Snow Job?
The Efficacy of Source Country Cocaine Policies

Kevin Jack Riley

RAND Graduate School
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RGSD-102

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The original version of this study was prepared as a dissertation in May 1993 in partial fulfillment of the requirements of the doctoral degree in public policy analysis at the RAND Graduate School. The faculty committee that supervised and approved the dissertation consisted of Peter H. Reuter (Chairman), Michael Kennedy, and Richard J. Kaplan.
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PREFACE

This dissertation was submitted in partial satisfaction of the requirements for the degree of Doctor of Philosophy in Public Policy Analysis at the RAND Graduate School.

The research examines the effects that source country drug control policies have on the production of cocaine in Bolivia, Colombia and Peru. The findings should be of use to policymakers who must balance the tradeoffs between supply and demand control programs, decide on the allocation of scarce drug policy resources, and plan the future direction of drug policy research.
SUMMARY

This dissertation presents a dynamic economic model of the cocaine industry and source country drug control policies. The model is used to assess the impact of eradication (voluntary and forced), interdiction, and development assistance on the production and export of cocaine from Bolivia, Colombia, and Peru. Most of the policies, with the exception of shock interdiction, can disrupt production for short (2-3 year) periods. However, even sustained levels of extreme policies (50% interdiction and eradication rates) fail to lead to permanent reductions in output. Policy cannot permanently reduce output because the cocaine industry is endowed with access to low-cost resources (land and labor), extreme mobility, and short recovery times between policy implementation and industry response.

Over the short run, the lag between policy implementation and industry recovery can lead to temporary disruptions of cocaine output. Short-run disruption of cocaine production may be of utility because of its potential impact on initiation rates into cocaine use and, subsequently, on future cocaine consumption. However, short-run disruptions are relatively expensive in terms of budget costs and externalities such as increased political violence and dispersal of cocaine production. Factors such as inventory accumulation, risk-related wage premiums, uncertainty about industry lag times, and the form used to model demand for cocaine create uncertainty as to the length of the short-run disruption resulting from a given policy.

Current levels of source country control programs are incapable of generating substantial disruptions, and thus the most compelling justifications for maintaining the current approach are found in the data source country policies generate about the international drug trade and the support source country control programs provide for foreign policy objectives in the region. It is unclear whether the benefits of expanded short-run disruptions outweigh the budget costs and externalities. Additionally, the prospects for integrating substantial short-run disruptions into the National Drug Control Strategy remain
unclear. Thus, much research remains to be done before substantial changes in source country control programs can, or should, be enacted.
ACKNOWLEDGMENTS

Any list of acknowledgments must begin with my dissertation committee members, for without the support of Peter Reuter, Michael Kennedy, and Richard Kaplan, this work would not have been possible. My chairman, Peter Reuter, brought invaluable scholarly guidance, critical commentary, and drug policy expertise to the committee. Peter is a pioneer in the field of drug policy, and my own research benefited substantially from his research endeavors. Mike Kennedy, with whom RAND’s efforts to model the cocaine trade originated, provided me my first chance to research drug policy and steered me through the complexities of modeling. Dick Kaplan was a steady resource throughout the process, adept at refining ideas and distilling reams of output into a usable form. Each gave generously of his time, and for that I am grateful.

I must also make special mention of the financial support provided by the Drug Policy Research Center, co-directed by Peter Reuter and Audrey Burnam; the International Policy Department, directed by Jonathan Pollack; and the RAND Graduate School, headed by Charles Wolf, Jr. Their support significantly speeded my progress and allowed me to pursue avenues of research that enriched the analysis.

Numerous friends, colleagues and family members helped me along the way: Patricia Brukoff, Cheryl Damberg, Michael Dardia, Mary Anne Doyle, Christopher Leslie, Dick Neu, Kent Riley, Patricia Riley, Peter Rydell, Karon Siano, Carole Simms, Darlene Thomson, Jeannette Van Winkle and Michael Wall to name a few. Each contributed support that was indispensable and I hope that one day I can return the favor.

Last, but not least, I owe an enormous debt of gratitude to Karen Yuhas. She is a shining star, and it is to her that this dissertation is dedicated.
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GLOSSARY

AHV  Associated High Valleys Project (Bolivia)
BCP  Bolivia, Colombia and Peru
CDRP  Chapare Regional Development Project
CORAH  Coca Reduction Agency (Peru)
DINACO  National Coca Directorate (Bolivia)
DIRECO  Direccion de Reconversion Agricola (Bolivia)
ENACO  National Coca Authority (Peru)
HA  Hectare
IBTA  Instituto Boliviano de Technologia Agropecuario
MACA  Ministry of Campesino Affairs and Agriculture
MT  Metric Ton
ONDCP  Office of National Drug Control Policy
PEAH  Special Project for the development of the Alto Huallaga Area
STRIDE  System to Retrieve Information from Drug Evidence
UHADP  Upper Huallaga Area Development Program
UHV  Upper Huallaga Valley
UMOPAR  Rural Area Police Patrol Unit
UNDCP  United Nations Drug Control Program
1. THE POLITICS AND POLICY OF SOURCE COUNTRY CONTROL PROGRAMS

COCAINE IN THE UNITED STATES: PROBLEMS AND POLICIES

Cocaine consumption is an important concern in the United States. Americans annually spend billions of dollars in pursuit of the high it delivers, resulting in millions of hours of lost productivity, hundreds of thousands of crimes, and thousands of emergency room admissions and deaths.\(^1\) The national response to the drug problem has been the implementation of a punitive prohibitionist stance against drug consumption.\(^2\) Users of drugs, and in particular, cocaine,\(^3\) are not addressed primarily from a medical or health care perspective, but rather as criminals. The strictness of the nation's drug enforcement regime against cocaine manifests itself widely, from stiff Federal drug sentencing guidelines to drug testing in the workplace.

Increasingly, the position of the drug hawks,\(^4\) or those who argue for toughness in federal drug strategy, is subject to criticism.\(^5\) The counternarcotics regime itself imposes distinct costs on society. Prisons are now populated past their legal capacities because of the flood of drug convictions, forcing communities to either expend more resources to expand capacity and incarcerate convicts, or release offenders early and prosecute only a portion of the cases that arise.\(^6\) Significant portions of the population, particularly young, black males, have been stigmatized with felony arrest records and now face even

---


\(^3\) Reuter (1991), p. 142 notes the rise in cocaine arrests relative to marijuana arrests since 1979. In 1979 when marijuana arrests were predominant, most arrests were for possession. However, distribution arrests now constitute a much larger share of total arrests than they did in 1979.

\(^4\) See Reuter (1992a) for a description of the hawks, doves and owls paradigm.


bleaker employment prospects.\textsuperscript{7} Toughness has precipitated a conflict both within the drug dealing community itself and between drug dealers and authorities that has brought very high levels of bloodshed and violence to American streets.\textsuperscript{8} Finally, in a strict anti-drug environment, where it is argued, treatment and education are underfunded,\textsuperscript{9} users who would otherwise seek help are dissuaded because of the lack of facilities, or because of the stigma society has attached to their problem. As a result, the core population of long-term, heavy cocaine users may be rising.\textsuperscript{10}

Implicit in the strict approach is the notion that controlling the supply of drugs reaching consumer markets is possible.\textsuperscript{11} However, much of the effort to control drug supplies is also explicit. If federal domestic enforcement programs are included in the tally of supply control programs, a full two-thirds of the federal drug budget is devoted to attempting to prevent drugs from reaching the markets through law enforcement, interdiction, and eradication. When state and local programs are considered, it is likely that we have spent over $100 billion over the past decade in an attempt to keep drugs out of buyers’ hands.\textsuperscript{12} Much of this policy effort is aimed at controlling cocaine.\textsuperscript{13}

\textbf{THE WAR OVER THERE}

In recent years, the drug war has again taken on a distinctly international flavor. The United States spends approximately $1 billion

\textsuperscript{7}Ibid.
\textsuperscript{8}Most of the violence occurs within the drug selling community and is not directed against authorities. (Reuter (1991) and Skolnick (1988)).) Nevertheless, enforcement is responsible for the violence to the extent that it dislocates street-level dealers into rivals’ territory where violent confrontation over markets is a likely outcome.\textsuperscript{9}Biden (1992); Reuter (1991).
\textsuperscript{10}One hint of this is found in the Drug Abuse Warning Network (DAWN) data, which show an increase in the number of heavy-use, drug-related hospital admissions.\textsuperscript{11}ONDCP (1992).
\textsuperscript{13}Direct computation of cocaine’s share in the national drug budget is not possible. Indirect evidence, such as the share of cocaine among all drug cases in the courts and the prisons, indicates that cocaine is a very high priority.
on international drug control programs.\textsuperscript{14} If attempts to stop drugs at the border are counted, this number rises to almost $3$ billion, or one quarter of the federal drug control budget.\textsuperscript{15} The focus on controlling foreign sources of drug supplies is not a departure from the historical norm, but rather represents a consistent pattern in the history of U.S. drug policy.\textsuperscript{16} In contrast to strict domestic enforcement, programs aimed at controlling drug production in, and exports from, foreign countries, offer a number of seeming advantages. First, an emphasis on foreign sources lends to the perception that authorities are tough on drugs and are intent on bringing those ultimately responsible for the drug trade to justice. At the same time, however, foreign policies lack the deleterious consequences of domestic repression, such as overcrowded prisons and street violence. The conflict, if any, takes place well beyond the confines of American borders. Such policies appear to generate results: drugs are seized, drug kingpins are arrested, and drug-producing crops are destroyed. Numerically, the problem appears simplified through the prism of source country control programs because it is a problem of thousands of traffickers and growers, rather than of millions of consumers. The policies are also fueled by the perception that the drug business is controlled by foreigners and by the belief that weak and corrupt foreign governments support the drug trade. In this sense, the "War on Drugs" takes on a national security dimension.\textsuperscript{17} In addition, since there is no indication that there has been a coalescence of national sentiment around more radical regimes such as legalization or less punitive programs such as 'grudging toleration,'\textsuperscript{18} source country control programs serve as a convenient interim policy. Finally, there is little evidence that either domestic supply or demand

\textsuperscript{14}ONDCP Executive Budget (1992). Figure includes source country control programs, as well as intelligence and other programs designed to improve interdiction programs.
\textsuperscript{15}ONDCP (1993), p. 4.
\textsuperscript{17}Indeed, President Reagan defined the drug problem in these terms in 1986.
\textsuperscript{18}For a range of alternatives on drug control regimes, see Nadelmann (1992a), Skolnick (1992), and Szasz (1992). Kleiman (1992a) develops the thesis of grudging toleration.

There are, however, externalities associated with source country control programs. Perhaps the most tangible consequence is that drug policy is made immeasurably more complicated since source country control programs must be coordinated across international boundaries beyond which the United States does not have jurisdiction. One example of this is the frequent changes in Colombian extradition policy. Because of the leverage the cocaine traffickers have over Colombian society, the United States cannot rely on the Colombian government to maintain a steady extradition policy posture.

A second consequence of source country control policies is that it sometimes leads to extensive U.S. involvement in foreign countries' domestic problems. In Colombia, the U.S. assistance has been used not only to prosecute counternarcotics aims, but to augment Colombia's capacity to defend itself against domestic threats to its political structure, raising fears that the outcome may parallel U.S. involvement in Vietnam.\footnote{Among the analyses developing the parallel explicitly is Andreas, et. al. (1992).} In contrast, in Peru the United States has abandoned many counternarcotics objectives because of the threat posed by the \textit{Sendero Luminoso}, an intense rivalry between the Peruvian national police and the military, and fears of potential human rights abuses.\footnote{McCormick (1991 and 1992) and Palmer (1992).} In either case, U.S. counternarcotics policy directly affects domestic issues in Colombia and Peru.

Source country control programs have also elevated the discussion of the U.S. military's role in counternarcotics policy. Civil libertarians worry that military involvement in counternarcotics efforts presages greater use of intrusive and coercive policies domestically.\footnote{Nadelmann (1985) and Szasz (1992), among others.} Military officials have reluctantly embraced a supporting role in anti-drug efforts, in part because other, clearly defined missions do not exist.
Finally, source country control programs are not without their domestic consequences. It is frequently asserted that attempts to control production of drugs in foreign countries can lead to adverse consequences in the consuming nation, the most striking example being the high potency of marijuana now available across the United States. The increase in potency likely represents an attempt by traffickers to reduce the bulk of their contraband in an effort to evade source country control programs operated in Mexico and Colombia in the 1970s and 1980s.\textsuperscript{23} High potency marijuana is associated with higher health risks.\textsuperscript{24} In yet another consequence of attempts to evade policies, much of the marijuana consumed in the United States is now produced domestically in California, Hawaii, and Kentucky.

DRUG CONTROL REGIMES AND SOURCE COUNTRY CONTROL PROGRAMS

U.S. problems with drug abuse can be traced back as far as the late 1800s when heroin and cocaine based drugs were considered miracle cures.\textsuperscript{25} Many such products were available over the counter in popular household elixirs, or widely prescribed by physicians. Even as early as 1909, when the United States participated in the Shanghai Opium Convention, its drug policy has been oriented toward addressing the external sources of the drug problem. The Harrison Narcotic Act, passed in 1914, demonstrated U.S. resolve by classifying opiates as illegal and initiating steps to restrict their import. The Act also proscribed sales of cocaine products, except through prescription. The U.S. government used the Act to monitor the flows of drugs into the country by taxing imports and requiring records to be kept.

As these and other regulations helped reduce over-prescription of addictive drugs, and as they helped educate the public about cocaine and heroin’s addictive potential, the drug problem receded from national prominence. When drug consumption again began to emerge as a policy issue in the late 1960s the United States shifted strategies away from multilateral conventions and toward aggressive bilateral programs that

\textsuperscript{23}Reuter (1991), p. 149; Falco (1989) reviews these strategies.
\textsuperscript{24}Jacobs (1987).
\textsuperscript{25}Musto (1992 and 1987).
directly targeted source country production. The movement to bilateral agreements under Nixon resulted in unprecedented U.S. involvement in foreign countries' drug control efforts. Beginning with the Nixon Presidency, the United States coordinated bilateral drug policy efforts against Turkish and Mexican opium, and Colombian and Mexican marijuana. These efforts are instructive, for the success they enjoyed is often cited in support of continued supply control programs.

**Turkish and Mexican Heroin**

In the late 1960s, Turkey supplied an unknown, but perhaps substantial, portion of the U.S. heroin market. Consequently, the U.S. government prevailed upon the Turkish government to impose a ban on poppy farming in exchange for monetary compensation. According to published reports, the ban resulted in an appreciable impact on U.S. heroin markets.\(^{26}\) Purity levels decreased, prices increased, and consumption levels declined. The ban, however, succumbed to Turkish domestic pressures, and by 1974 the Turkish government had reformulated the policy to allow poppy cultivation for legal opium production. The government enforced this ban with stringent regulations against production for the illegal markets, including the destruction of all village poppy crops if even one villager was caught selling to the illegal markets.\(^{27}\)

At about the time Turkey allowed poppy cultivation to resume, Mexico emerged as the leading supplier of heroin to the United States. Mexico's emergence as the primary supplier stands out because it had no heroin problem of its own and prior to 1974 was not known to be a large producer of poppies. Mexico thus succeeded in developing an export-oriented poppy industry virtually from scratch in a very short period of time. Subsequently, the U.S. government redirected its efforts toward Mexican poppy production. Mexico agreed to participate in the effort, and large reductions in Mexican heroin output soon resulted. The Mexican effort is notable because chemical eradication was a prominent

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\(^{27}\) Reuter (1985), p. 90.
tool in the campaign. Heroin use in the United States was again reported to decline from 1975-1979.

At first glance, these policies would appear to confirm the belief that there is merit in striking at the source of production. Upon closer inspection, however, the gains achieved in terms of output reduction not only appear to be the result of fortuitous circumstances, but also appear to have imposed nontrivial costs on society. Both Turkey and Mexico maintained strong, in some cases repressive, government control over the cultivation regions in question and thus were able to exert institutional control over the regions with little fear of violent repercussions. This is in stark contrast to Peru and Colombia, where the government wields weak authority in the growing regions, and where guerrilla activities pose threats to government control. In Bolivia, coca farmers pose a direct challenge to the state's ability to implement policy through coca growing syndicates organized to protect farming interests in the open political system. In addition, the relatively high wages, at least by developing country standards, in Mexico and Turkey, tended to make the two countries less cost-effective producers, while the relative unimportance of the heroin industry in the local economies tended to reduce the political problems associated with suppression. Incomes are much lower in Peru and Bolivia, and the populations are much more dependent on drug production, increasing the likelihood of violent resistance to efforts to reduce production. Also, at least in the case of Mexico, poppies held no special cultural significance, again in contrast to the role that coca has in the history of Andean society.

Other considerations were relevant to the success the policies enjoyed as well. Most of the farming in Mexico and Turkey took place in areas that were open and vulnerable to policy implementation. Little effort, for example, was made to conceal Mexican poppy cultivation

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28 Craig (1980).
29 Reuter (1984) reports on the problems of determining the number of heroin addicts. See also Reuter (1993).
30 See Lupsha (1981) for more on Mexican authority over growing regions.
because, until 1974, there was little threat from law enforcement officials. In the aftermath of the programs of the 1970s, however, Mexican growers simply shifted cultivation to more remote, less accessible locations.\textsuperscript{32} Where once the Mexican drug industry was geographically contained, production now extends throughout much of the country.\textsuperscript{33} It is also worth noting that the disruptions to U.S. heroin markets were short-lived. Turkey cracked down on production in 1971, and Mexico replaced Turkey as the largest supplier to the United States in less than two years. More recently, poppy cultivation has been detected across the border from Mexico in Guatemala. Very recently poppy cultivation has been noted in Colombia.

The policies resulted in no long-term reductions in the supply of heroin reaching the United States. Price data indicate that heroin is now more readily available on the streets of U.S. cities than ever before, and at some of the lowest prices on record. To be sure, the mix of suppliers has changed over time, and this change is in large part due to policy pressure imposed on the producers.

**Mexican and Colombian Marijuana**

Many of the efforts directed at Mexican poppies were duplicated for Mexican and Colombian marijuana. Indeed, much of the equipment used to eradicate poppies was also used against Mexican marijuana. Perhaps the most ambitious aspect of the Mexican program was the herbicidal eradication effort the government undertook. Mexican authorities, using U.S.-supplied equipment, sprayed thousands of acres of marijuana with Paraquat. The result was a precipitous drop in the demand for Mexican marijuana in the United States out of concern that smoking marijuana that had been treated with Paraquat would result in serious health consequences on the user.\textsuperscript{34} Colombia assumed the role of lead supplier

\textsuperscript{32}Reuter and Ronfeldt (1992), p. 5.

\textsuperscript{33}Drug Control: US-Mexican Opium Poppy and Marijuana Aerial Eradication Program (1988).

\textsuperscript{34}Demand reduction for a single drug does not necessarily reduce total substance abuse. DiNardo (1992) for example, has shown that teenagers will substitute alcohol for marijuana when the latter becomes unavailable. Similar substitutions may exist between cocaine and other intoxicants.
to the United States until the early 1980s when Mexico regained its production cost advantage as maritime interdiction of Colombian marijuana shipments forced up Colombian prices.

The success against Mexican and Colombian marijuana also forced other innovations in the industry. Interestingly, the United States began to supply a sizable portion of its own demand through domestic production. U.S. suppliers, concentrated in Hawaii, California, and Kentucky, now satisfy approximately 30% of the U.S. market.\textsuperscript{35} Some of the cultivation has moved indoors to greenhouses in an effort to evade detection by authorities. And since marijuana is a bulky product, the producers have devoted efforts to increasing the potency of their product in an attempt to both condense the volume and increase the value relative to weight. By all accounts, this effort has paid off, as marijuana potency has increased substantially over the past decade.

\textbf{COCAINE AND SOURCE COUNTRY CONTROL POLICIES}

With the success of the marijuana and heroin models in mind, the United States embarked down the source country control path for cocaine in the 1980s. Since 1981 over $100 billion has been spent in an attempt to control the supply of drugs, with over $4 billion of that money going to source country abatement programs. Table 1.1 shows how federal money was allocated between program alternatives, as well as the approximate proportion of this spending devoted to programs in Bolivia, Colombia, and Peru (hereafter referred to as BCP) for 1992 and 1993. BCP's share of interdiction funding cannot be computed, since interdiction typically operates at the U.S. border, rather than in the producing nations. Most assuredly, a large portion of the illicit drugs seized at the border have their origins in BCP, and thus BCP 'account' for a substantial portion of the interdiction budget. The portion of the 'Equipment and Military Assistance' category going to BCP is listed as '>' or 'more than' since some of the spending in these programs targets Latin America without specific reference to BCP. Finally, law enforcement assistance, which includes investigations, eradication operations, and other items,

\textsuperscript{35}Kleiman (1989), pp. 71-73, reports on the growth in and organization of domestic marijuana production.
does not logically break down by source country and thus is listed as not applicable.

Table 1.1

Funding for Source Country Control Programs

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Portion of total to BCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdiction</td>
<td>2216.8</td>
<td>na</td>
</tr>
<tr>
<td>Equipment and military assistance</td>
<td>235.2</td>
<td>&gt;73%</td>
</tr>
<tr>
<td>Law enforcement</td>
<td>267.9</td>
<td>NA</td>
</tr>
<tr>
<td>Economic assistance</td>
<td>255.6</td>
<td>100%</td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interdiction</td>
<td>2219.6</td>
<td>na</td>
</tr>
<tr>
<td>Equipment and military assistance</td>
<td>235.6</td>
<td>&gt;83%</td>
</tr>
<tr>
<td>Law enforcement</td>
<td>245.4</td>
<td>NA</td>
</tr>
<tr>
<td>Economic assistance</td>
<td>268.8</td>
<td>100%</td>
</tr>
</tbody>
</table>

NOTE: Figures for 1992 are estimates and for 1993 are requests. NA: not applicable.

Despite the efforts devoted to source country control programs, cocaine production continues to expand across a number of fronts according to 1992 estimates.\footnote{INCSR (1992); ONDCP (1992).} Reports indicate that the area devoted to coca cultivation continues to grow, that the trade continues to spread its operations to other Latin American nations, including Brazil, Argentina, and Venezuela, and that the volume of shipments to Europe is growing.

Supporters offer any number of explanations why source country policies have not proven effective. First, the source countries are often accused of half-hearted pursuit of counternarcotics objectives. Of course, in order for policies that involve operations on foreign soil to have any hope of reducing the production and export of cocaine, the United States needs the cooperation of the Andean nations. Cooperation has varied over the course of the past decade. For example, although the United States regards Bolivia as a faithful ally in the war on
drugs, Bolivia nevertheless has begun to chafe against meeting voluntary eradication targets. Bolivian authorities fear that all of the farmers willing to participate in voluntary eradication have done so, and that further efforts in this direction will only provoke a violent response. Colombia, on the other hand, has endured high levels of drug-related violence. Some of the violence is linked to opposition to Colombian counternarcotics policies that might not exist in the absence of U.S. pressure. Extradition is one example.

It is also sometimes offered that the policies are appropriate, just poorly planned and executed. This argument surfaced as aid from the Andean Initiative started to flow to the Andean nations. Colombian authorities criticized Washington for sending down inappropriate equipment and materiel.

Another frequent complaint is that we have devoted inadequate resources to the problem. It is clear that cocaine commands a large place in Andean society, and efforts to counter its influence must be correspondingly grand, according to this line of thinking. The counterdrug effort needs to be carried out on a much larger scale than it currently is. Eradication, currently confined to small, voluntary programs in Bolivia, needs to be expanded to much larger, compulsory campaigns across the region. Following this line of reasoning, interdiction, now funded at modest levels relative to the size of the cocaine industry, needs to be hugely expanded to quickly and decisively affect the industry.

The issues outlined above discuss the level of policy activity and the environment in which the policies operate. Missing from the analysis, however, is whether the policy can lead to the desired result even if it faces no obstacles to implementation. In other words, it is equally plausible that no matter how well the policy is executed, it won’t have the desired effect on the drug industry and that the cocaine industry defies effective regulation. This report is an attempt to address the first order question: Can source country control policies

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37Riley (1993).
38See for example, The Drug War: Counternarcotics Programs in Colombia and Peru (1992).
be effective at reducing the production of cocaine? If the answer is yes, it will then be possible to turn to questions of efficiency and whether policy is being implemented properly. If the answer is no, the discussion will turn to how policy might be improved, and what changes should be considered.

A Modeling Approach

To systematically investigate the impact of various production control programs, a model of the cocaine trade, and the structural and economic influences that surround it, was developed. The model provides a framework in which the various factors constituting the cocaine industry can be compared in terms of their influence over industry output. The modeling framework allows for an assessment of what happens when specific policy levers are pulled, not only to the production of cocaine (the visible effect) but the underlying economic structure of the cocaine industry (the economic incentives that determine participation in cocaine markets).

Central to this model is a representation of the cocaine economy’s interaction with legal economic activity. The general equilibrium approach demonstrates how the cocaine economy draws on resources from the larger economy, such as flows of labor from regions where employment opportunities are scarce. In addition, the general equilibrium approach also shows how efforts to control the cocaine economy will affect the national economies, providing a measure of potential political obstacles to the programs.

The source country control policies examined will fall into one of two broad categories:

- **Coercive**: These strategies can assume a number of forms, from seizure of cocaine-generated assets and more effective prosecution of traffickers to shutting down processing sites, stepping up interdiction efforts, and forced eradication. Under this form of policy, the goal is to directly raise the risks and uncertainties associated with production so that the higher costs of business are passed along to the users, who are then discouraged from consumption.
• **volitional:** Programs in this category reward participants for not engaging in cocaine production. At the farm level, this represents providing the laborers with viable economic alternatives to coca production through development assistance and subsidies for voluntary eradication. At the level of cocaine traffickers, the amnesty programs and lenient sentence options offered by the Colombian government qualify as ‘carrot’ programs.

Coercive and volitional policies are evaluated along four dimensions:

• How much cocaine do the policies remove from the production pipeline, and for what length of time?
• How quickly can the trafficking industry recover from policy measures?
• What are the impediments to efficient policy implementation and how do these obstacles affect policy’s impact?
• How sensitive are the results to limited knowledge about the structure and operation of the cocaine industry?

The primary issue is assessing which source country policies seem most likely to be effective at reducing the production and export of cocaine, and how these effects compare to the costs of implementation and the effects on the producing nations’ economies. The measure of effectiveness is the amount of cocaine removed from the streets and the length of time that it takes the industry to resume full production. The cocaine trade's adaptive ability is touted as one of its strongest assets, and thus the industry’s ability to respond to policy is the second major consideration. How quickly can the cocaine trade regroup to counteract abatement policies and the regrouping effective against the policies? The analysis will consider what short-term benefits, if any, can be derived from the time gap between program implementation and trafficker response. The efficiency with which policy can be implemented constitutes the third line of analysis. The political environment in BCP is a difficult one in which to operate, and even policies that can be expected to be effective against their target face severe constraints to efficient implementation. Thus, the analysis will
explore the problems and prospects of efficient implementation, given the anticipated effectiveness of source country control options. The final criteria is how the policies in question lend themselves to modeling. Data on the cocaine trade are inherently difficult to come by and of varying quality. The consequences of plausible changes in model assumptions and data will thus be explored.

Section 2, provides basic background on the evolution and structure of cocaine production and describes some of the characteristics that will be incorporated in the model. This section also describes in more detail the source country control programs that have been implemented in BCP. Section 3 details the basic model used to represent the cocaine trade and the assumptions and parameters embedded in the modeling structure. Section 4 reports on the results of imposing a range of policy options on the model of the cocaine production process. Finally, Section 5 develops the policy implications of the simulations: which policies work, which fail, and the implications for establishing source country control programs' role in national drug control strategy.
2. THE COCAINE INDUSTRY AND SOURCE COUNTRY CONTROL POLICIES

Consumption of cocaine induces neurochemical changes that magnify the pleasure associated with most activities.\(^1\) Higher doses of the drug will yield increased mood-altering effects, and thus, while cocaine does not produce physical dependence akin to heroin, the high the drug produces encourages pursuit of more intense intoxication by producing a form of psychological addiction.

The method of ingestion affects the speed with which the high is delivered. Of the two primary consumption methods, nasal inhalation and smoking,\(^2\) consumption through the nasal passages produces intoxication more slowly. Nasal passages have relatively few blood vessels and capillaries, and consequently the absorption of the drug into the bloodstream is slowed. In contrast, inhalation of cocaine vapors directly into the lungs provides a powerful high very quickly because the concentration of capillaries in the lungs leads to rapid bloodstream absorption. Regardless of the form consumed, higher rates of cocaine use eventually decrease the length of the chemical high obtained.\(^3\)

Because nasal inhalation infuses cocaine into the system more slowly, the pharmacological impact remains longer. The impact delivered through smoking, while rapidly felt, also rapidly fades. Withdrawal from the chemical euphoria will leave the user depressed, anxious, and craving more of the pharmacological pleasure.

The user can suffer direct health consequences ranging from anxiety and hyperactivity to panic and severe paranoia. Indirect consequences range from increased risk of contraction of sexually transmitted disease to increased risk of coronary problems.\(^4\) A mother who consumes cocaine during pregnancy imperils her fetus’ health. The known consequences of cocaine consumption during pregnancy include:

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\(^1\)Gawin and Ellinwood (1988), p. 1174.
\(^2\)The term smoking is a misnomer, since crack is not actually burned, but heated to release a vapor.
\(^3\)Gawin and Ellinwood (1988); Siegal (1992).
malformations, growth abnormalities, and behavior problems. In terms of aggregate effects on national health, cocaine pales in comparison to the effects of alcohol and cigarettes, but only because both are much more widely abused.

Cocaine hydrochloride, or cocaine, dissolves in water and thus can be consumed intranasally or intravenously. Cocaine undergoes chemical changes when heat is applied that cause it to lose its euphoric properties. Crack, or cocaine alkaloid, however, is not water soluble but retains its pharmacological properties when heated. Thus cocaine cannot be smoked, and crack cannot be consumed using water as the medium. In either case, the cocaine product that reaches the streets represents the end product of successive refinements of a stimulant produced naturally in coca plants, a medium-sized woody plant common to Latin America.

Coca: The Root of It All

The production of cocaine is a simple process, both in terms of the inputs required, and in comparison to the production of other psychoactive substances, such as heroin. Cocaine is produced in four stages: leaf is cultivated, reduced into paste, purified into base, and then, finally, converted into cocaine. This section will describe the industry in detail, including the policies used to target the various stages of production.

Cocaine production begins in the intermontane valleys and upper jungle regions of Bolivia, Colombia, and Peru (BCP). There, the conditions are nearly perfect for the farming of the coca plant, the foundation of the cocaine industry. Coca has deep roots in Andean society, stretching back many centuries into Andean history. Coca has religious and cultural significance as a medium between man and God in Andean society, and it has also been used as a medium of exchange. In addition to being ascribed mystical qualities, coca has been, and still

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5Zellman et. al. (1992), p. 3.
7Cooper (1989).
is, used to relieve fatigue, hunger, and sorochi, or altitude sickness, common throughout the region.9

Coca plants grow well in steeply sloped, poor-quality soil. Coca tolerates substantial rainfall, growing well in regions receiving 1000-4200 mm of annual precipitation.10 The plants live as long as 30 years and can provide initial harvests 6 months after planting, and mature harvests in as few as 18 months. In raw coca leaf the average cocaine concentration is approximately .75%,11 ranging from approximately .1% to 1.2%.12 Some legal coca farming takes place in Peru and Bolivia to meet local traditional demand, as well as to satisfy the small international market that exists for coca leaf.13 Coca farming is not legal in Colombia.

Coca is, in many respects, the ideal commercial plant. Foremost among coca's attributes is the fact that it provides up to six harvests per year, many more than most other crops. These harvests provide year-round income, an advantage that seasonal crops cannot offer. In addition, coca reaches production maturity much faster than other permanent crops, such as coffee and tea. Coca is hardier than most other crops, more resistant to climatological variations, weeds, insects,14 and other potential hazards,15 though it is subject to damage from cold and frost.16 Coca also requires little in the way of processing infrastructure, spoils relatively slowly, and does not damage during transport.17 Another advantage is that coca can grow in poor and

13Coca leaf, for example, is used as a flavor additive in some cola products, after the cocaine alkaloids have been removed.
14Coca Cultivation and Cocaine Processing: An Overview (1991), pp. 12-13 reports on insects that damage coca plants. All can be controlled through the use of pesticides.
15There are frequent reports that coca plants are vulnerable to fungus infections, particularly during the wet season (Coca Cultivation and Cocaine Processing: An Overview (1991), p. 13).
16Antognini (1990), p. 65.
17The leaves, however, can be ruined by moisture. According to Coca Cultivation and Cocaine Processing: An Overview (1991), p. 3, if the leaves are left out in the rain after harvest, the accumulation of moisture will lead to the breakdown of the cocaine alkaloids.
depleted soils as a replacement for crops that have exhausted existing
farmland or it can be used to expand the agricultural frontier to
otherwise unusable property, including that which is steeply sloped.
Though the plant grows best between 500 and 1500 meters, it is adaptable
to lower altitudes, albeit with lower cocaine concentrations. 18

In the higher altitudes the basic strategy among the traditional
farmers is to minimize economic risk by diversifying cropping
practices. 19 These methods evolved over time in response to the highly
varying climatological conditions in the Andes, and to the high cost and
slow dissemination of agricultural technology. A typical highland
farmer, therefore, will plant a number of different crops at a variety
of altitudes facing several different exposures. Because of the steep
slopes common to the highlands, coca farming in the higher elevations
often occurs on elaborate, terraced plots of land. Coca will usually be
included among the crops grown because of the year-round harvests and
subsequent cash income it provides. Although the highland farmers do
not supply much of the cocaine trade’s coca, as land becomes
increasingly scarce and infertile, the farmers’ ability to maintain
traditional techniques and production independence is threatened, and
a growing percentage of the highland population is forsaking the
production of all other crops and focusing on coca production. Such
farmers are known as monocroppers, since they cultivate only one crop,
usually coca.

The lower valleys, particularly the Chapare in Bolivia and the
Upper Huallaga Valley in Peru, produce the majority of the world’s coca,
and here monocropping is already very common. This is primarily a
reflection of the influence that the drug industry has had on farming
practices in these areas. To some extent, however, it also reflects
other factors, including land quality that was poorer than anticipated
at the time when settlement was being encouraged, the migration to the

18 Ibid., p. 65.
19 For a discussion of risk aversion and diversification see:
Browman (1987); Andean Peasant Economics and Pastoralism (undated);
valleys of labor pools that have few agricultural skills relevant to the subtropics, and persistent production problems with other crops.\textsuperscript{20} Figure 2.1 shows the main highland and lowland cultivation areas and their proximity to regional and national population centers. In general, the highland regions correspond with the traditional cultivation. That is, cultivation in the highland regions did, and largely still does, serve legal domestic demand. In contrast, the lowland regions typically were established to serve the cocaine industry. The Chapare, located at the eastern edge of the Cordillera Oriental mountain range, and the Upper Huallaga Valley, nestled in a valley between the Cordillera Azul and Cordillera Occidental, are the primary suppliers of the cocaine industry. Cuzco and Yungas, located at much higher elevations tend to supply legal demand, although both, particularly the former, serve the illicit markets as well.

\textsuperscript{20}The particulars of coca production in the Chapare and the Upper Huallaga Valley are discussed in subsequent sections.
Fig. 2.1—Traditional and Cocaine Industry Coca Cultivation Regions

The marketing of coca typically takes place in towns and villages proximate to the coca fields. Some markets, such as the six that serve
Bolivia’s Chapare, are municipally sponsored and, at least ostensibly, federally regulated. At these formal markets, prices are posted for three qualities of leaves. First quality leaves, as measured in terms of color, spotting (from mold, etc.), and suppleness, command the highest price and are typically desired by cocaine traffickers because of the quantities of cocaine the leaves yield. Second and third quality leaves, which are subject to a 15%-35% discount, require more processing for lower yields. Much of the commerce, however, takes place at night after the markets have closed, or along the sides of the roads leading into and out of the villages.

Coca farming is the most labor-intensive stage of the cocaine production chain up to the point of wholesale export.\textsuperscript{21} In addition to clearing and preparing the fields for planting coca seedlings, coca farming may require periodic applications of insecticides and herbicides, as well as frequent weeding and pruning. Coca plants are often purchased as seedlings and transported to areas where full-scale production will take place. Once the coca plant has reached maturation for harvest, large amounts of labor are required to pick the leaves and transport them to local markets. The skills required for coca farming do not differ substantially from the skills required for licit agriculture and, in fact, in many cases are less demanding, making coca a logical income crop for the agricultural laborers across BCP.

**The Upper Huallaga Valley, Peru**

Peru’s coca production is concentrated in the Upper Huallaga Valley (UHV), a Massachusetts-sized area of roughly 9900 square miles split between Huanuco and San Martin departments. Stretching from the village of Puerto Cuyumba in central Huanuco to Tocache Province in southern San Martin, the region produced, at its peak, 30%-40% of the world’s coca supply. Aided by government relocation programs, coca farmers have steadily penetrated deeper into the UHV. The Marginal Highway assisted this effort by opening the interior of the country, leading to the creation of large settlements and towns such as Tingo

\textsuperscript{21}See the input-output table on the value of cocaine production in Kennedy, Reuter, and Riley (1993a).
Maria. Not only did the completion of the road open vast tracts of the interior to settlement, but it helped demystify what had been a remote and isolated area. The UHV's population increased at an average annual rate of 6% between 1965 and 1988. This growth was in part sustained by government programs to colonize the interior of the country and, later, because of the opportunities the coca trade offered.

As a result of the colonization, the upper jungle regions experienced a number of agricultural booms and busts prior to the 1970s. Coffee and bananas, for example, were expected to lead the development of the UHV in the 1950s and 1960s. By 1970 with the collapse of the Peruvian coffee trade the UHV was without a steady cash crop. The promising banana trade, for example, was cut short by a disease that limited its geographic range. Beyond natural hazards such as disease and climate, the peasants poorly understood the agricultural potential and limits of the Valley. Even though the state encouraged colonization, it did little to determine how much of the land was agriculturally viable and how commercial agriculture would fare in the jungle.

In fact, while the UHV's lands were adequate for limited farming, the desired transformation to commercial agriculture required large investments in agriculture and development projects. First, the soils around the UHV were generally of poorer quality than those in the central and lower Huallaga valleys, and than the soils in other regions. Since the government had not adequately studied the concept of agricultural development in the UHV, this fact was not well known at the time the colonization process was beginning apace. Second, what agricultural development programs did exist seemed to be less adequately promoted in the UHV. The coastal area of Peru received the bulk of agricultural development funds, and what money was transferred to the jungle was often dedicated to irrigation programs that did not meet UHV development needs. Also, the government was notorious for agreeing to

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23 Strug and Martel, p. 697.
24 Strug and Martel, p. 695.
buy food products at a specified price, only to be forced by volatile
economic conditions to offer payment in kind at a later date. In
addition, the government subsidized food imports as part of a commitment
to maintaining affordable food prices, particularly for non-agriculture
city dwellers,\textsuperscript{26} making it difficult for farmers to profitably supply
the nation with agricultural products.\textsuperscript{27} Table 2.1 illustrates the
difficulty in earning a profit on crops other than coca in the UHV.
Note that coca has the highest profit rate by far, despite having the
second highest cost of production.

Table 2.1

<table>
<thead>
<tr>
<th></th>
<th>Profit per hectare\textsuperscript{a}</th>
<th>Cost of Production ($/hectare)</th>
<th>Yield (kg/hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coca</td>
<td>1,680</td>
<td>720</td>
<td>1,200</td>
</tr>
<tr>
<td>Tea</td>
<td>-820</td>
<td>1,100</td>
<td>4,000</td>
</tr>
<tr>
<td>Coffee</td>
<td>-170</td>
<td>440</td>
<td>500</td>
</tr>
<tr>
<td>Cacao</td>
<td>-160</td>
<td>440</td>
<td>400</td>
</tr>
<tr>
<td>Red Beans</td>
<td>-140</td>
<td>390</td>
<td>700</td>
</tr>
<tr>
<td>Corn</td>
<td>10</td>
<td>430</td>
<td>1,700</td>
</tr>
<tr>
<td>Rice</td>
<td>-90</td>
<td>690</td>
<td>4,000</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Net present value

NOTE: Compiled from "Analysis of Coca Industry Generated from Chapare Leaf Production" (1990). \textsuperscript{a}Net present value of 1 year's revenue.

The opening of the UHV lands to settlement and commercial farming
that exceeded the region's development capacity augmented the expansion
of the coca market in three specific ways. The primary impact has been
to encourage the population of so-called marginal lands, or plots that
are not well suited to supporting licit agriculture. In addition, land
use patterns in the UHV have shifted away from seasonal agriculture and
toward the cultivation of permanent crops, of which coca is one.
Finally, use and settlement patterns have overtaxed many of the more
valuable commercial lands of the UHV, weakening the soil even further.
Marginal lands may compose as much as 80\% of the UHV's territory, and as

\textsuperscript{26}Alberts, op. cit., pp. 233-247.
\textsuperscript{27}Alvarez (1992), p. 4.
little as 7% of the land may be suitable for licit agriculture.\textsuperscript{28} As a consequence, the agricultural frontier has continued not only to move outward on to less agriculturally viable land, but has become weaker as existing farmlands are overworked. As a result, over the past twenty years the growth in food production in the UHV has failed to match the growth in population, leading to the need for food imports into the area from the surrounding departments.

**The Chapare, Bolivia**

The Chapare is the primary coca growing region in Bolivia, supplying over 60% of the Bolivian market, and 15% of the world market for the product. The Chapare is an area approximately the size of New Jersey, bounded by mountains and the traditional coca cultivation areas of the highland valleys to the west and south and lowland jungles to the south and east. The Chapare sits approximately midway between the major regional cities of Cochabamba and Santa Cruz, the latter having assumed the role as the nerve center of the Bolivian drug trade. North of the Chapare lies Beni Department, home of most of the drug refining and processing that occurs in Bolivia.

Coca farming in Bolivia has strong historical roots, although cultivation of it in the Chapare developed strongly as an international commercial product only after the completion of the highway between Cochabamba and Santa Cruz, and the land reform of 1952.\textsuperscript{29} Land reform curtailed the latifundia land tenure system, under which Bolivian Indians provided the latifundarios with free labor. Once released from this system, the Bolivian Indians were free to migrate in search of

\textsuperscript{28}Garland (1987), p. 310. Potential land use statistics reflect, to an unknown degree, philosophical differences about colonization. The figure cited above is from a 1983 ONERN (Nation Office for the Study of Natural Resources). A 1964 ONERN study conducted during Fernando Belaunde's tenure found only 11% of the land to be marginal. In light of the growing consensus that the UHV has endured severe ecological damage, it seems prudent to accept the higher estimate of marginality. Generally, the poorer the quality of the land, the longer it must remain fallow to regain productive capacity. Fallow periods of seven years and more are suggested for the region.

\textsuperscript{29}Klein (1985); Healy (1985).
other employment. Opportunities began to develop with the completion of the Santa Cruz-Cochabamba Highway in the 1950s. As Santa Cruz became integrated with the rest of the nation, and as the travel time between the region and the rest of the country was cut from several weeks to two days, farmers in the region began to develop an agricultural base to serve the rest of the country.

From the opening of the highway through the late 1970s, Bolivia’s economy was organized around the exports of primary products and attempts to develop agricultural markets. The world markets for primary products, particularly tin, proved volatile, and ultimately failed as stable sources of employment. A similar story emerged in the agricultural sector as well. Sugar cane was one of the first crops to be commercially exploited in Santa Cruz, but Bolivia’s place in world markets proved tenuous. Segments of the commercial farming industry in and around Santa Cruz, particularly cotton farmers, were devastated by weak international prices.

Gradually commercial agricultural production lost its luster and was supplanted by coca. According to land use surveys of the Chapare, legal cultivation of bananas, rice, yucca and oranges constituted approximately 75% of agricultural activity and coca approximately 25% in 1971. By 1985 the percentage of coca had risen to 66% and legal cultivation had declined to 34%. At the center of this shift was a core of wealthy ranchers and landowners who had accumulated substantial marketing assets, including aircraft and contacts in foreign countries. Their involvement was facilitated by virtue of the region’s geographic isolation, their experience shipping products over long distances, and the presence of a weak and corrupt central government through August 1981. The fall of Meza’s corrupt government presaged intensified counternarcotics efforts in the Chapare which ultimately led to an even wider dispersion of the trade.

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32 Ardila (1990), p. 7. Study conducted by CIDRE, Center for Research and Regional Development.
During this period, the Chapare grew rapidly in population. In 1967 the population stood at around 27,000, but by 1987 had climbed to over 200,000. Many of those who settled in the Chapare came from the highlands, particularly the Yungas region, where coca was traditionally farmed for personal and legal use and other food crops were grown for subsistence. This particular wave of settlement, described as spontaneous, lasted through the 1970s and was marked by a farming population which, while devoted to legal forms of agriculture, did not abandon the heritage of coca farming. This particular population segment’s ties to the illicit coca market was weak.

The settlers arriving between 1970 and 1986, differed from the previous group. Much of the settlement was still spontaneous, although a substantial portion of the movement was also directed by a variety of government programs. Regardless, most from this group of migrants did not possess the skills to farm in the tropics, yet few non-agricultural opportunities were available in the underdeveloped area. As a result, many from this wave of migrants settled into coca farming since it requires little in the way of agricultural expertise. This group formed the core of the early coca-cocaine economy of the late 1970s and early 1980s.

Finally, beginning in 1986, a third wave of migrants devoted almost exclusively to growing and processing coca began to settle in the Chapare. Table 2.2, which shows the profits associated with farming in the Chapare in 1987, illustrates why coca farming had such tremendous allure. No crop matches coca for its profitability at a price of $100 per carga. Even when the price of coca falls to as low as $40 per carga, coca is almost as profitable as some other crops, but sharply lower than others. Moreover, obtaining profits associated with legal

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33Healy (1985), p. 102
34DESPIL (1987). Using a variety of estimation techniques, this report gives population estimates ranging from 197,000 to 274,000 people. Other sources, including USAID (1991), point to a figure of slightly over 200,000.
36Cultivos de Coca, (1992), p. 3.
37Ibid., p. 4.
crops assumes continued subsidies from the government. Without the inclusion of subsidies, the profitability of most crops would fall substantially.

Coca provides this revenue despite its relatively low weight. Other crops in the table yield up to eight times the output by weight, complicating transportation and shipping arrangements. Oranges and bananas are also much more easily damaged in transit than coca. Another factor to consider is that the table compares the profits reaped from a developed coca market to the potential profits from legal markets that do not yet exist. It is likely that, as markets for legal agriculture expanded, the market prices for the goods would fall, leading to lower profits. Continuation of the same projected profit levels would require either ongoing production subsidies or the development of export markets. In either case, coca would likely still prove to be the most profitable crop. Finally, it is worth pointing out that coca matures more quickly than most of the other crops listed in the table, meaning that it provides profits sooner, and with less uncertainty, than other crops.

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38For example, the profit estimates for other crops include the $2000 bonus offered to someone who voluntarily eradicates his coca fields.
Table 2.2

Profits for Crops in Subtropical Bolivia

<table>
<thead>
<tr>
<th>Crop</th>
<th>Profit per hectare</th>
<th>Years to first commercial harvest</th>
<th>Profit per metric ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coca ($100/Carga)</td>
<td>17,714</td>
<td>1.5</td>
<td>$5,368</td>
</tr>
<tr>
<td>Coca ($40/carga)</td>
<td>2,530</td>
<td>1.5</td>
<td>767</td>
</tr>
<tr>
<td>Pineapple</td>
<td>10,022</td>
<td>2-3</td>
<td>NA</td>
</tr>
<tr>
<td>Macadamia Nuts</td>
<td>5,436</td>
<td>5-7</td>
<td>NA</td>
</tr>
<tr>
<td>Oranges</td>
<td>4,280</td>
<td>4-5</td>
<td>271</td>
</tr>
<tr>
<td>Coffee</td>
<td>4,110</td>
<td>3-8</td>
<td>NA</td>
</tr>
<tr>
<td>Cacao</td>
<td>3,087</td>
<td>2-3</td>
<td>NA</td>
</tr>
<tr>
<td>Corn</td>
<td>2,761</td>
<td>&lt;1</td>
<td>NA</td>
</tr>
<tr>
<td>Bananas</td>
<td>2,522</td>
<td>&lt;1</td>
<td>93</td>
</tr>
</tbody>
</table>

NOTE: Compiled from Drug Policy and Agriculture (1991); Kumar, Carter and Samuelson (1986); Final Report on the Evaluation of AID Project No. 527-0244, Development of the Alto Huallaga Area (1987); and conversations with United States Department of Agriculture officials. *Net present value of 10 years’ revenue. NA: not available.

Extent of Coca Cultivation

Coca farming extends deep into Andean society. Figure 2.2 shows that coca farming has continued to grow in recent years throughout the Andean region. Peru remains the world's leading producer, accounting for approximately half of the world's coca production. Bolivia is the world's second largest producer. Also, Colombia has increased the area it cultivates in recent years, although, again, Colombian leaf does not yield as much cocaine because of the quality of the leaf. Figure 2.2 shows the expansion of cultivation throughout the Andean ridge.
Fig. 2.2—Coca Cultivation, 1985-1990

Eradication

Without coca, the drug traffickers could not make cocaine. Throughout the last decade, the United States has supported numerous marijuana, poppy, and coca eradication programs. The ability of eradication to stop production at its source, as well as its perceived technical and logistical simplicity, makes it an intuitively appealing policy option. In order to be effective the eradication has to be complete and involve the removal or death of the entire plant. Chopping the plants down, for example, is not sufficient, since, if the root system is not removed or destroyed, the plant will grow back, perhaps even providing higher yields. Likewise, merely stripping the leaves off does not constitute eradication, but rather is what happens when coca leaves are harvested.

Eradication can take one of two forms: manual and herbicidal. Manual eradication offers greater political acceptability with the
producing nations and has been experimented with in the past. The
difficulty with manual eradication lies in the fact that men and
equipment must be moved in large numbers to remote growing areas. Once
there, the coca plant itself proves resilient to eradication efforts.
It takes perhaps 20 man days of effort to pull up an entire hectare of
coca plants by their roots.\(^{39}\) Once pulled up, the plants themselves
must be destroyed or burned so that processors and traffickers do not
retrieve the plants once the eradication teams leave the area. While
the numbers of people required to eradicate the entire coca crop in
Bolivia might not be prohibitive, other costs of the operation might be.
For example, 10,000 people working full-time could eradicate perhaps
100,000 hectares in a year. However, it would prove extremely difficult
to transport and defend 10,000 eradication team members in the
relatively friendly confines of Bolivia, let alone in the hostile and
forbidding coca regions of Peru.

In fact, it is the security threat that poses the most difficult
challenge to manual eradication, particularly in Peru. Large portions
of Peruvian territory remain under effective control of the Shining
Path, a guerrilla organization that has plagued the countryside for over
a decade.\(^{40}\) The Shining Path's control over rural territory, including
many of the primary coca producing regions, means that an effective
eradication policy would need to surmount this formidable obstacle. In
fact, the opposite has occurred, and eradication workers have endured
armed attacks at the hands of insurgents in the Upper Huallaga Valley.
As a result, Peruvian eradication operations have been scaled back and
are now concentrated in more remote areas of the Valley and are directed
at seedbeds. Bolivia confronts a different problem with respect to
eradication policy. In Bolivia, an organized union represents the
interests of coca farmers at the national level, which presents the
government with an entrenched, vocal opponent, albeit one that does not
possess the violent, revolutionary nature of the Shining Path in Peru.
Nevertheless, Bolivian farmers have repeatedly expressed opposition to

\(^{39}\)Lee (1989).
\(^{40}\)For a comprehensive look at the Shining Path, its history,
strategy, and objectives, see McCormick (1990 and 1992).
eradication, and the threat of escalation to violent confrontation is present. Only in Colombia does the opposition to eradication appear less visibly, perhaps due to the fact that Colombian society is so overwhelmed with other symptoms of the drug trade, and because coca farming is of minor significance in Colombia.

In contrast, herbicidal eradication promises greater ease of implementation but conjures up visions of chemical contamination, environmental destruction, and other ecological, political, and social problems. Recent studies point to potentially effective herbicidal treatments for coca plants. At least two herbicides, tebuthiuron and hexazinone, demonstrate the ability to kill coca plants. Questions persist, however, as to whether these chemicals are appropriate for use in the tropical environment in terms of soil persistence, damage to other crops, and the health hazard posed to humans in the area. In addition, the use of herbicides to eradicate coca raises the larger issue of whether eradication, herbicidal or otherwise, poses a larger threat to the environment than coca farming.

Nevertheless, herbicides can be aerially applied, reducing the transportation needs and risks of armed conflict to personnel. In addition, though the products can be aerially applied, they are not administered in aerosol form. Rather, they are applied in a pellets form which substantially reduces the possibility of drift contamination and increases the accuracy with which they can be delivered. As a practical matter, however, herbicidal eradication remains politically unpalatable, and thus much less likely to be employed than manual eradication.

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41One of the more famous examples involved the Peasant Coca Farmers Union closing off a main road from La Paz to Santa Cruz for several days. See Bagley (1985).


43Tebuthiuron sells under the brand name Spike, and is manufactured by Dow Elanco. Hexazinone is known as both Velpar and Pronone and is made by E. I. Du Pont de Nemours and Company. Both herbicides are already in commercial use worldwide.

44Cocaine Production, Eradication and the Environment: Policy, Impact and Options (1990) examines this issue in more detail.
In some respects, the choice of eradication method may be irrelevant. If the policy is ineffective at reducing the production and supply of cocaine, then it probably does not merit much consideration as a policy option. The exception to this generalization arises if there is some political benefit to be derived, either domestically or abroad, from maintaining a small eradication program. One of the first steps in the analysis, then, is to look at the impact that past eradication policies have had on the production and export of cocaine.

**Eradication in Peru**

In the early 1980s, the Peruvian government, encouraged and supported by the United States, attempted to curtail illicit coca farming in the UHV through a forced eradication program. The results of the program were discouraging. At its peak in 1984, the program destroyed less than 4000 ha per year, a relatively low number in comparison with both the size of the plant stock in the UHV (approximately 116,000 ha) and with the rate at which the plant stock depreciates because of aging (approximately 770 ha). Still, supporters of the policy point out that significant bureaucratic and logistic problems hampered the effort and prevented further progress from taking place.\(^{45}\)

By far the most important obstacle encountered in the course of eradication was violent opposition from the peasants. While to be expected, and sometimes even interpreted as a sign of policy success, the violence that erupted in the UHV assumed a much darker dimension in 1983 when the Shining Path, or Sendero Luminoso, began to assert its authority throughout the Valley. The Shining Path succeeded in depicting the program as an imperialistic attack on local interests and began coordinating violent counterattacks against the government eradication teams. In August 1984, the Peruvian government placed the region under a state of emergency and ordered in army troops to stabilize conditions. Attempts to quell the violence, however, met with

little success. Shortly after the army's arrival, narcotics traffickers murdered 19 eradication workers.46

Despite stepped-up Peruvian efforts to contain the Shining Path, the area has since remained under effective guerrilla control. Because of the danger to personnel, the United States withdrew its support for forced eradication efforts in 1987, confining its support to seed-bed eradication programs at the edge of the UHV. Since then it has wrestled with the increasingly difficult issue of how to pursue counternarcotics objectives in Peru. The issue is complicated by frequent complaints of human rights abuses by the army in the region, by the ineffective control that the government maintains over army and police units, and by corruption among the parties in charge of counternarcotics efforts.47

Recent reports indicate that a natural form of eradication may be occurring in the UHV.48 A fungus, fusarium oxysporum, has killed off thousands of hectares of coca plants in the UHV. This fungus, which apparently only affects coca plants, was detected in 1987, and has spread throughout the valley and resulted in widespread economic hardship. At the same time the fungus has been detected spreading throughout the UHV, reports are surfacing that the coca trade is dispersing more widely throughout the region, including the Central and Lower Huallaga valleys.

Eradication in Bolivia

The Bolivian government committed itself to modest eradication objectives in 1983 as well. The United States conditioned continued receipt of over $80 million in development assistance and narcotics control aid on Bolivian eradication of 4000 hectares of coca by 1985 and establishment of effective narcotics police control over the region.49 Despite these commitments, however, the Bolivian government took little

47The Drug War: US. Programs in Peru Face Serious Obstacles (1991).
49Drug Control: US.-Supported Efforts in Colombia and Bolivia (1988).
action, and the U.S. government responded by implementing procedures under which aid was to be withheld in the absence of a firm commitment to counternarcotics efforts. In May 1985, the Bolivians moved to defuse the crisis by drafting legislation that restricted coca farming to the highland regions, and which would have subjected all coca farming in the Chapare to eradication. The decree, however, was never implemented by the legislature and, thus, did not have the force of law. The Bolivian government relented to U.S. pressure in 1988 and enacted Ley 1008, a law which made most coca farming outside traditional high altitude coca zones\(^{50}\) illegal.\(^{51}\) The non-traditional areas, such as the Chapare were designated transitional zones, were given a 10-year period in which to voluntarily eradicate all coca, and were targeted with development assistance to encourage voluntary eradication. At the end of the transitional decade, all coca cultivation in non-traditional areas is to become illegal as well. Subsequently, the United States began to compensate peasants in the Chapare $2,000 per hectare removed from production in the transitional zones.\(^{52}\) Production taking place outside of the traditional and transitional zones was considered illegal and subject to forced eradication. In addition, all acreage in the transitional zone placed under cultivation after enactment of Ley 1008 was also considered illegal and subject to eradication.

Since implementation of the agreement, Bolivia has found it difficult to meet the voluntary eradication targets in the transitional zones. The complaints regarding the failure of the voluntary eradication program have ranged widely. There have been complaints about the slow speed with which farmers were compensated for eradication, and also about how slowly alternative development programs designed to reward villages for eradication came on line. In addition, Bolivian authorities have noted that interdiction operations have failed to keep leaf prices low on a sustained basis. It is believed that consistently low leaf prices would force farmers to consider the option of voluntary eradication. Bolivian authorities blamed wet weather in

\(^{50}\)The Yungas is the major traditional zone.  
\(^{51}\)Ley 1008, (1988), articles 9-11, pp. 4-5.  
\(^{52}\)Of this, $1650 is in cash, $350 in labor.
1991 for limiting regional activities, including farming and development, and consequently for reducing the incentives to voluntarily eradicate. Additionally, authorities point out that those who have yet to participate in voluntary eradication are unlikely to do so because they settled in the region primarily to participate in the cocaine trade and lack basic farming skills needed for other crops. On the U.S. side, officials point to lackadaisical enforcement of Ley 1008, particularly the prohibition against new cultivation in the transition zones as a contributing factor to the slow pace of voluntary eradication.

The lax enforcement of the prohibition against new cultivation is a particularly sore point in U.S.-Bolivian counternarcotics relations. The U.S. side sees it as the key to ensuring the success of voluntary eradication since the law permits destruction of legal coca plants if the farmer is found in violation of laws governing transitional coca. Bolivian officials, for their part, are very reluctant to conduct forced eradication. They fear that forced eradication will radicalize the peasants and result in an armed conflict between the eradication teams and the farmers. This fear is grounded not only in the experience of Peru in the early 1980s, but because of the strength that the coca unions maintain throughout the Chapare.\(^53\) Several times already the coca unions, or sindicatos,\(^54\) have blocked commerce in the region by shutting down the main highway to show their distaste for coca policies and have mobilized members to participate in hunger strikes, "chew-ins," sit-ins at government offices, and public protests. The local sindicatos have also succeeded in keeping the issue of coca cultivation on the national farming agenda through their affiliation with the national peasant labor organization. A number of armed confrontations have already occurred in the region over the issue.\(^55\) The fact that DINACO, the Bolivian authority created in conjunction with Ley 1008 to

\(^{53}\)The unions were created at the time of the 1952 land reform to address local community needs. Healy (1991), p. 88.

\(^{54}\)Sindicatos function at the community level. They are aggregated into centrales above the community level, and into federaciones at the national level. Two federaciones control approximately 85% of the sindicatos in the Chapare. Healy (1991), pp. 88-89.

\(^{55}\)Personal communication, DIRECO official in Villa Tunari.
regulate coca markets, must negotiate with farmers in several of the regional coca markets for the right to regulate markets that it is authorized, and required, by law to monitor, is a measure of the farmers' strength. Similarly, farmers have continued to evade sanctions against farming illicit coca because DIRECO, the state coca reduction agency, has yet to conduct a census of new and old coca that would allow authorities to distinguish between legal and illegal coca.

Compensation for voluntary eradication may also, perversely, act as insurance for those who decide to undertake coca farming. Compensation establishes a floor price. When coca prices are above the compensation price, farmers have no economic incentive to eradicate. When prices are below the floor, the compensation provides the farmers an income and thus helps underwrite the downside risk associated with coca farming. In other words, the only way a farmer will not benefit is if he grows no coca at all.

The future of eradication in the Chapare is not promising. For the reason discussed previously, forced eradication will remain problematic. At the same time, however, voluntary eradication is likely to become increasingly impractical over the next few years. At the age of 3-4 years, coca plants acquire a moss at the base of the plant. Once this moss is present it is virtually impossible to tell the age of the plant. This has a dramatic impact on voluntary eradication programs because, under the program's rules, the United States cannot offer compensation for coca planted in the transitional zone after the enactment of the 1988 law. However, because authorities failed to complete a land-use census in 1988, and have not done so since, they have lost their ability to distinguish between 'legal' coca in the transitional zone (that planted before 1988) and 'illegal' coca in the zone (that planted after enactment of Ley 1008). Without the ability to distinguish between crops, the program acts as insurance for farmers who planted illegally. As a result, it is unlikely that the program will endure in its present form.
Eradication, 1984-1991

Table 2.3 provides a summary of eradication efforts in BCP and includes recent figures on Mexican poppy eradication for comparison.\(^{56}\) Perhaps the most noticeable element of the table is that Mexico eradicated a much higher percentage of its poppy crop than BCP have achieved with respect to coca. A number of factors contribute to this difference. First, the scale of Mexican poppy cultivation was substantially smaller than the scale of the coca problem; Mexican poppy cultivation required about 9000 ha in 1988. This fact, combined with the extent to which Mexico has made use of herbicides, simplified the task of eradication. In contrast, Peruvian coca cultivation in the UHV alone requires roughly 55,000 hectares, or 212 square miles, of land that are widely scattered throughout the valley. The remote, rugged terrain, combined with the physical danger faced by eradication teams, has made manual eradication virtually impossible. Second, Mexican authorities have been much more cooperative about eradication than their South American counterparts. Mexico commits approximately 25\% of its army personnel to eradication, a far higher level of activity than has ever been achieved in Bolivia, Colombia, or Peru. Despite the rate of Mexican eradication, the program did little to alleviate heroin consumption in the United States.\(^{57}\)

\(^{56}\)Mexico has also executed extensive marijuana eradication. Marijuana was omitted from consideration because INCSR (1990), pp. 185-195 shows marijuana cultivation of 9000 ha in 1989, but nearly 58,000 in 1990. The difference is not attributed to an expansion of cultivation, but rather, improvements in estimation techniques. In any event, the drastic shift in estimates renders the eradication comparison moot.

\(^{57}\)INCSR (1989).
Table 2.3
Eradication Efforts, 1984-1990

<table>
<thead>
<tr>
<th>Country</th>
<th>Crop</th>
<th>Hectares Eradicated (% of acreage)</th>
<th>Cost ($U.S. millions) a,c</th>
<th>$Cost Per Hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico, '84</td>
<td>poppies</td>
<td>1,126 (17.8%)</td>
<td>4.16 b</td>
<td>3,694</td>
</tr>
<tr>
<td>Mexico, '85</td>
<td>poppies</td>
<td>2,297 (23.4%)</td>
<td>4.85 b</td>
<td>2,111</td>
</tr>
<tr>
<td>Mexico, '86</td>
<td>poppies</td>
<td>2,383 (28.4%)</td>
<td>5.80 b</td>
<td>2,434</td>
</tr>
<tr>
<td>Peru '87</td>
<td>coca</td>
<td>2.80</td>
<td>1.60</td>
<td>312</td>
</tr>
<tr>
<td>Peru '88</td>
<td>coca</td>
<td>5,130 (4.4%)</td>
<td>1.60</td>
<td>312</td>
</tr>
<tr>
<td>Peru '89</td>
<td>coca</td>
<td>1,285 (1.1%)</td>
<td>2.00</td>
<td>1,556</td>
</tr>
<tr>
<td>Peru '90</td>
<td>coca</td>
<td>1,476 (3.0%)</td>
<td>20.00</td>
<td>1,556</td>
</tr>
<tr>
<td>Bolivia '88</td>
<td>coca</td>
<td>2,504 (4.6%)</td>
<td>230 (0.8%)</td>
<td>64</td>
</tr>
<tr>
<td>Colombia '88</td>
<td>coca</td>
<td>641 (1.5%)</td>
<td>641 (1.5%)</td>
<td>64</td>
</tr>
</tbody>
</table>


aExclusive of aircraft purchases, foreign assistance, and aid contingent on eradication or other counternarcotics objectives. bAssumes eradication budget divided equally between marijuana and poppy programs. cUS. funds only.

The impact of eradication on coca markets is even less clear. For example, it is difficult to discern the impact of eradication on coca prices. Of the three primary leaf producers, Bolivia has regularly collected price data for coca since approximately 1987. In contrast, Peruvian price data have only been available since 1990. In Bolivia, DINACO, the national coca authority, attempts to collect price information from transactions in 6 Chapare coca markets, while in Peru, the prices are constructed from DEA, PEAH, and UNDCP estimates. Local resistance, however, prevents DINACO from operating in at least two of the six markets, and thus the price surveys are not complete. In addition, DINACO obtains information on market transactions only, not illegal transactions that occur outside the markets. 58 Despite these shortcomings in reporting mechanisms, however, it is likely that DINACO’s reports reasonably reflect local prices because law enforcement pressure in the region is not sufficient to drive a substantial, permanent wedge between market and extra-market prices.

58The capacity to get extra-market prices through informants is being developed.
Figure 2.3 shows the variation in Bolivian and Peruvian leaf prices over the 1987-1992 period, as well as eradication occurring in Bolivian during the same period. Most of the eradication shown in Figure 2.3 is from voluntary eradication. However, it is not clear that prices are directly affected by the level of eradication effort. First, much of what is eradicated is probably old stock that has neared the end of its productive life, and which therefore was likely to be removed from production anyway. Second, since the eradication in question is primarily voluntary, it would seem that prices and eradication would be negatively correlated: high leaf prices would yield lower voluntary eradication rates because the compensation floor is lower than the prevailing price, and low prices would result in higher voluntary eradication rates since the floor compensation would exceed earnings from coca farming. Finally, Peruvian prices have been increasing relative to Bolivian prices. This suggests that coca farming may be undergoing substantial structural changes that is making production in Peru more attractive relative to production in Bolivia, and underscores the need to collect information between, as well as within, countries.

It is also important to note that the price variations existed before eradication commenced. Fluctuations in leaf price result as much from factors such as oversupply of leaf and climatic considerations as from eradication. One of the largest declines in prices, that of the September-December 1989, can be attributed to the Colombian government’s destruction of refinery capacity and the consequent decline in demand for coca, rather than on the impact of eradication. Alternatively, reduced price variation may mark traffickers’ attempts to stabilize coca markets, thereby easing farmers’ concerns about income variation as well as providing cocaine processors with a more stable supply of leaf inputs. More generally, the pattern of changes in leaf prices show wild swings even for relatively low eradication rates. At best, the information about leaf prices is incomplete and does not allow an assessment of eradication’s impact on prices.

60 Spedding, p. 5.
Alternative Development

Eradication is not expected to work alone. Rather, it is part of a three prong attack on the cocaine industry.\textsuperscript{61} The second prong, alternative development and economic assistance, is designed to provide the farmers with the means and incentives to quit coca production permanently. To that end, a number of strategies have been implemented throughout the Andean region.

Alternative Development in Bolivia

Migrant labor from other parts of Bolivia, particularly the highland valleys, supplies the Chapare with the work force it needs to produce coca. Thus, in addition to attempting to reduce coca farming directly in the Chapare through eradication, the United States has also supported projects designed to stem the flow of labor to the Chapare in

an effort to limit the labor pool available for coca farming. In Bolivia, the largest attempt to control migration is the Associated High Valleys (AHV) project. The AHV is an area adjacent to the Chapare that not only supplies the coca zone with some of the migrant and seasonal labor needed for coca production, but is also the origin of many of the homesteaders who have settled in the Chapare. The AHV projects entail a series of development projects designed to increase opportunities in the AHV in hopes of both stemming the flow of seasonal and migrant labor to the Chapare, and attracting back some of the migrants who have moved to the Chapare.

The AHV programs have received modest levels of funding, on the order of less than $5 million for each of FYs 1989-92. Agriculture in the AHV is constrained by the availability of arable land, and yet agriculture is the primary activity of most of the population. The projects therefore tended to focus on expanding the arable land stock through the augmentation of irrigation and soil management techniques.\(^{62}\) Combined, funding for irrigation and soil management projects accounts for about 65% of the short-term projects implemented and 50% of the long-term projects put in place.

Early anecdotal reports indicate that the population of the Chapare is declining, though there is no indication that those who have left are settling in the AHV. Rather, it appears, again largely according to anecdotal information, that the migrants out of the Chapare are the traditional farmers who settled in the area in the pre-1970 phase. Many of these farmers are committed to legal agriculture and have turned over their coca acreage to eradication authorities. On balance, those remaining in the Chapare appear to be more committed to illicit coca farming and impervious to exhortations to voluntarily curb their cultivation activities.

For those remaining in the Chapare there are a number of programs intended to pull them away from coca farming. USAID/Bolivia, for example, provides marketing and export assistance, agricultural extension and research services, credit, and infrastructure development.

programs. The AHV and Chapare development programs are premised on effective law enforcement pressure causing interest in voluntary eradication and alternative crops. To compensate the Bolivian government partially for lost revenues, particularly lost foreign exchange, the U.S. government provides up to $66 million in balance of payments support. This funding is designed to transform the Bolivian economy through increased employment, income, investment, and productivity gains in non-coca activities. Continuation of this development support is predicated on development and implementation of sound macroeconomic policies and maintenance of counternarcotics goals, including voluntary eradication targets.

**Alternative Development in Peru**

Two factors continue to hamper prospects for alternative development in Peru. First, the generally unstable nature of the Peruvian economy prevents implementation of national programs such as balance of payment support. Factors such as hyperinflation and exchange rate overvaluation lower profitability and discourage investment in programs that would otherwise be used to lure farmers away from coca.

Second, widespread political violence, primarily perpetrated by the Shining Path or Sendero Luminoso, has complicated the picture. Much of the countryside is effectively in control of the guerrillas, and thus the government cannot ensure the protection of development workers. In the past, those found to have cooperated with the government on

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development projects have been subject to retribution from the guerrillas.

Despite these two obstacles, a number of development programs have been implemented over the past decade, most aimed at controlling the coca trade in the Upper Huallaga Valley. This area was targeted for assistance as early as 1981 with the commencement of the Upper Huallaga Area Development Program (UHADP). UHADP consists of three parts: eradication, development and commercialization, and control of coca commerce. CORAH, Peru’s national coca eradication authority, was given responsibility for the eradication programs; PEAH (Special Project for the Development of the Alto Huallaga) was directed to establish and implement a regional development program; UMOPAR (Mobile Rural Police Unit) agents became responsible for regulating coca commerce in the UHV.

Evaluations conducted of the project in 1986 showed disappointing results. The primary shortcoming was the fact that coca maintained a tremendous economic advantage over all other forms of commerce in the valley, and no amount of interdiction and development was adequate to overcome this leverage. Many of the farmers whose plots were eradicated simply relocated elsewhere in the valley and replanted their coca.

By 1986 several menacing factors combined to create an extremely violent atmosphere in the UHV. Coca farmers reacted negatively to the eradication programs and often resorted to violent methods of protests. The unpopularity of the eradication in turn provided an opening that the Shining Path exploited by encouraging the peasants to use violence. Finally, the drug dealers themselves increasingly resorted to violent tactics in an effort to not only protect themselves from law enforcement operations, but from the Shining Path guerrillas as well.

Poor relations between the various authoritative agencies operating in the valley complicated issues. In particular, the Peruvian Army, charged with suppressing the Sendero, and the police, tasked with counternarcotics operations, demonstrated an inability to cooperate.

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67 Ibid., p. 3.
In part because of the poor cooperation between authorities, violence in the area continued to grow and many development programs were discontinued. As a result, the Upper Huallaga Valley's development needs remain massive. Studies have shown that the UHV needs development assistance on the order of $500 million to improve the road system alone in the coca zones.69

FROM COCA TO COCAINE

Farmers and Traffickers

The coca markets do not exist in a vacuum, but rather prosper and decline in conjunction with the cocaine trade. Land and labor are the primary inputs into coca production for the cocaine markets, and for all practical purposes both have been available as inputs into the coca market for decades. In this sense, then, land and labor are necessary to the development of coca production, but they are not sufficient to have caused it to expand in the absence of a catalyst. In order for coca to flourish, an outlet for it had to exist. During the late 1970s organized Colombian cartels began to build cocaine markets as opportunities in the marijuana trade waned. Carlos Lehder, who became one of the cocaine trade's leading traffickers for a time, was instrumental in this transformation. Imprisoned in the United States for a brief time on a marijuana charge, Lehder, together with his cellmate, saw cocaine as a potentially lucrative venture.70 The Colombians preserved the institutional knowledge and key personnel associated with marijuana trafficking, expanding the cocaine trade while law enforcement concentrated on marijuana.71 Among the remnants of the marijuana trade were trafficking routes and distribution networks, including contacts in transshipment nations such as the Bahamas.72

Other Colombians were well capitalized from the profits earned by smuggling operations. The Ochoa family, for example, ran a small import-export firm in Miami that served as a cover for smuggling

69Huallaga Valley Agribusiness and Marketing Study (1985).
70Eddy et al., pp. 131-148, especially pp. 132-133.
71Gugliotta and Leen (1989), pp. 30-31 and 74-76.
72Eddy et al., pp. 99-108.
operations.\textsuperscript{73} This meant the Colombians had the resources to invest in the startup capital they needed to get the cocaine trade off the ground.\textsuperscript{74} The Colombians, then, had all the tools necessary to shape the cocaine trade. But how did the experience translate into building the coca trade?

According to some reports\textsuperscript{75} the Colombians' involvement with coca trafficking of Peruvian leaf goes back beyond 1973. How the Colombians and Peruvians first managed to link forces is a story that is probably destined to remain obscure. In Bolivia, the link between coca markets and the Colombian cocaine industry is clearer: Bolivian entrepreneurs, particularly Roberto Suarez, transferred assets from their struggling legitimate agricultural activities to solidify connections to Colombian dealers.

The cartelization of the coca trade filled several gaps in rural Peruvian and Bolivian life. First, allegiance to the cocaine industry compared favorably to the bureaucratic agriculture programs available in rural Bolivia and Peru.\textsuperscript{76} By dealing with the smugglers, the peasants had no need to register their crops with the national coca administrations, or endure the bewildering morass of the credit process for other crops. Too, the UHV and Chapare were without a strong authority structure. The national governments did little to address the peasants' needs, and the peasants in turn had little allegiance to the formal government. The strong individualistic streak in the people of the valleys worked against development projects that required communal cooperation and tailored well with the desire for independent farming. Coca allowed the farmers to maintain independence and still earn a profit, usually a cash profit, at a time when sales to the government resulted in missed payments.

Over time the coca trade has changed shape. Originally, much of the traffic moved in the form of dry leaf to be processed in Colombia.

\begin{itemize}
  \item \textsuperscript{73}Eddy et al., pp. 32-33.
  \item \textsuperscript{74}For a concise overview of Colombia's role in the evolution of the cocaine trade, see Thouni (1992).
  \item \textsuperscript{75}Oggiolotta and Leen (1989), p. 22.
  \item \textsuperscript{76}For more on the relationships between farmers and buyers, see Morales (1989), pp. 75-84.
\end{itemize}
Transporting leaf meant toting about a low-value good in large quantities. It made more sense to avail themselves of the chemicals available in the region to process on site and transport small, high-value packages. Soon the peasants were processing the leaf into paste and base in the UHV and Chapare. This backward integration proved to be a significant step in the evolution of the coca market for two reasons. First, it gave the coca farmers a much larger economic stake in maintaining the trade. Second and more important, the evolution of the trade to on-site processing was the first step that took the farmers beyond the coca market and bound them to the cocaine market. As leaf prices continued to fall in response to the expansion of cultivation, greater and greater numbers of farmers became involved in paste processing.

Table 2.4 summarizes the process of transforming leaf in each country (Bolivia, Colombia, and Peru). The balance of this section is devoted to explaining the manufacture of cocaine in more detail. Table 2.5 shows the distribution of the various manufacturing activities among BCP. This table ignores the small amounts of manufacturing that take place in other countries.77

Table 2.4
Conversion Ratios in Cocaine Production Chain

<table>
<thead>
<tr>
<th>INPUT</th>
<th>Hectare land</th>
<th>MT leaf</th>
<th>MT paste</th>
<th>MT base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf (MT)</td>
<td>Bolivia</td>
<td>1.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colombia</td>
<td>.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peru</td>
<td>1.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paste (MT)</td>
<td>Bolivia</td>
<td></td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colombia</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peru</td>
<td></td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td>OUTPUT(^a)</td>
<td>Base (MT)</td>
<td>Bolivia</td>
<td>357</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colombia</td>
<td>1.6(^b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peru</td>
<td>345</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cocaine (kg)</td>
<td>Bolivia</td>
<td>--</td>
<td>909</td>
</tr>
<tr>
<td></td>
<td>Colombia</td>
<td>909</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peru</td>
<td>909</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: \(^a\)Outputs weighted to reflect different processing ratios within country for regions and types of coca plants. \(^b\)Colombian leaf is processed directly from leaf to base; amount entered in output base column reflects hectare:base ratio. Source: INCSR, 1989.

Table 2.5
Percentage Flow of Cocaine Trade Products between Bolivia, Colombia, and Peru

<table>
<thead>
<tr>
<th>Source of Product</th>
<th>Percent of Product Processed in:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bolivia</td>
</tr>
<tr>
<td>Leaf</td>
<td></td>
</tr>
<tr>
<td>Bolivia</td>
<td>99</td>
</tr>
<tr>
<td>Colombia</td>
<td>0</td>
</tr>
<tr>
<td>Peru</td>
<td>0</td>
</tr>
<tr>
<td>Paste</td>
<td></td>
</tr>
<tr>
<td>Bolivia</td>
<td>90</td>
</tr>
<tr>
<td>Colombia</td>
<td>0</td>
</tr>
<tr>
<td>Peru</td>
<td>0</td>
</tr>
<tr>
<td>Base</td>
<td></td>
</tr>
<tr>
<td>Bolivia</td>
<td>35</td>
</tr>
<tr>
<td>Colombia</td>
<td>0</td>
</tr>
<tr>
<td>Peru</td>
<td>0</td>
</tr>
</tbody>
</table>
Coca Paste

The heart of the cocaine industry is the release and concentration of the cocaine alkaloids from the coca plant. In some varieties, the alkaloids are more easily obtained than in others. Hence, Peruvian and Bolivian leaf are preferred to Colombian leaf because the alkaloids are more readily extracted. The initial release of alkaloids marks the second stage of cocaine production. This stage is commonly referred to as paste production because the coca leaves are soaked in chemical solutions and mashed into a gray-white paste. Chemicals used to extract the alkaloids include sulfuric acid, kerosene, lime, and bicarbonate of soda. In addition, the paste-making process requires water and maceration pits made of cement or plastic. Water is essentially a free resource, and the remainder of these items, from the chemicals to cement, are readily available throughout the coca growing regions. Labor, too, is readily available, and again the skills required are not complex. Typically, the paste stage requires an individual with knowledge about the proper mix of processing chemicals, and adequate manual labor for mixing, mashing, packaging, and transporting the paste. Security becomes a more important element in the paste stage of production because paste output, unlike coca farming, is clearly an undertaking that is designed to supply an illegal market.

In the 1960s, coca farmers in Bolivia laced cigarettes with small amounts of coca paste, which were then smuggled into Chile, Argentina, and Brazil. These cigarettes, known as pitillos, formed the core of the early illicit narcotics trade in the Chapare. Cochabamba served as the center of Bolivian refining. During the 1979-1980 period, the industry underwent a fundamental change organized by a powerful group of ranchers, businessmen, and military officers. As law enforcement pressure against the growing trade increased, the heart of the trade relocated from Cochabamba to Santa Cruz, a city geographically and

---

78 Plowman, p. 18. The leaf cultivated in the Chapare is apparently not acceptable for traditional use because it does not readily release the alkaloids upon mastication.
politically remote from the weak central government. The geography around Santa Cruz favored the expansion of the trade as well. The large, flat plains around the city allowed the products to be shipped out by aircraft and allowed the traffickers to abandon the slow and cumbersome overland routes out of Cochabamba. Roberto Suarez capitalized on the fleet of planes he had accumulated to ship beef from his remote ranches in Beni to markets in Chile to also ship coca paste to Colombia, expanding Bolivia’s role in the international drug trade.\textsuperscript{81} By the early 1980s he had become Bolivia’s most important trafficker.

\section*{Coca Base}

In paste form the cocaine alkaloids have been released from the coca leaves and are ready for further refinement. The next stage of production is the base stage, and it is when the coca paste is rid of processing impurities and the cocaine alkaloids are further concentrated. Base production requires chemicals such as sulfuric acid, potassium permanganate, and ammonia. Other variations of the process substitute acetic acid for sulfuric acid and ammonium hydroxide for ammonia. A third conversion recipe requires only acetone to process the paste into base.\textsuperscript{82} These conversion processes again require materials such as water and mixing containers, as well as simple drying and filtering equipment. This stage of production is more complicated than the paste stage and typically requires larger, more sophisticated facilities. Base labs, therefore, tend to be located in very remote regions, far from coca growing and population centers. The majority of coca base is shipped to Colombia for processing into cocaine. Hence, at the base stage more complex shipping arrangements, such as airstrips and overland trafficking routes, need to be arranged. Transshipment to Colombia, therefore, necessitates cross-border smuggling, a process that often entails bribing local police, airport, and customs officials.

\textsuperscript{81}Orellana and Zanner, (1983), 153-154.
\textsuperscript{82}The recipes for processing coca leaf into cocaine vary slightly, depending on the region where the processing is occurring and the type of leaf being processed. The above-mentioned general formulas were found in “Recipe Book: Cocaine Processing Techniques,” (DEA: Lima Country Office), undated.
Also at this stage, the vast networks of informants maintained to keep track of anti-narcotics law enforcement plans become more important as the trafficking becomes international in scope.

Generalities about this stage of production are difficult to make. Profit margins at this point in the production chain are apparently very small relative to the value of the product.\textsuperscript{3} Since base is one of the most expensive inputs into cocaine, many traffickers integrate vertically at this stage, and produce both base and cocaine. While authorities have uncovered a variety of sophisticated labs with large processing capacities, many of the labs tend to embody crude technology and require minimal capital investment. Analysts suspect that many of these labs, large and small, do not operate full time, but that the traffickers rotate between a series of labs in order to reduce the threat of law enforcement detection.\textsuperscript{4} Recent reports also indicate that the traffickers are more frequently resorting to storing their production in a suspended solution, known as aguarica (rich water), in an effort to improve its shelf life and provide an inventory hedge against interdiction.

\textbf{Cocaine Hydrochloride}

The final step in the production process, then, is to process the base into cocaine hydrochloride, or cocaine, the purest and most marketable form of the drug.\textsuperscript{5} Conversion from base to cocaine makes the product soluble, enabling the consumers to ingest it through nasal passages. This process again involves the use of equipment and chemicals similar to those used in the other stages of production. Sophisticated processing labs are often set up in remote regions of the

\textsuperscript{4}“Analysis of Coca Industry” (1992), p. 10.
\textsuperscript{5}The intermediate products themselves can be consumed. Errors in processing that result in poor quality base, and hence poor quality cocaine, are increasingly consumed by residents of the producing nations. The various non-cocaine hydrochloride forms are often referred to as ‘bazooka’ or ‘basuco.’ These forms of cocaine retain many of the pharmacological properties associated with cocaine. Morales, p. 113, notes the history of such consumption. MacDonald (1989) discusses the extent of cocaine product consumption in BCP.
countries. These well-guarded sites, while often set up to process large quantities of cocaine, are also designed to be both mobile and redundant. The mobility allows the processing to be moved rapidly to other locations in case of law enforcement interference. The redundancy of processing equipment ensures that even if one, or several, labs are shut down, processing capacity will not be crippled by losses. After final processing into cocaine, the product is ready for shipment to the United States and other markets. At this stage, then, transportation and security are major considerations. Transportation needs include long-range aircraft, landing strips, intermediate transshipment points, boats, radar, and fuel. Intelligence information, bribery, and security also take on new importance as the smugglers try to penetrate the anti-narcotics measures implemented by the United States.

**Law Enforcement and Interdiction**

Interdiction and law enforcement measures remain the cornerstones of U.S. counternarcotics policy. They consume approximately two-thirds of the supply control portion of the federal drug budget. Moreover, they retain an important psychological role in the national battle plan.

As executed against the cocaine trade, interdiction actually embraces two distinct components. First is the actual interdiction of cocaine itself. Second, and equally important, are efforts to control the tools of the trade. Interdiction raids thus often entail attempts to destroy processing laboratories, arrest trafficking personnel, and seize assets such as transportation aircraft and processing chemicals. Combined, the seizure of cocaine and attacks against the structure of the trade represent interdiction. The sections below consider two programs notable for their size and scope.

**Operation Blast Furnace**

 Implemented in Bolivia in 1986, Operation Blast Furnace was one of the first attempts to 'go to the production source' of cocaine. That is, Operation Blast Furnace included raids on processing laboratories, arrests of cocaine industry personnel, and seizure of industry assets, in addition to the interception of cocaine. By a number of measures,
Operation Blast Furnace was a success. For example, it eased regional transportation problems by creating an infrastructure that Bolivian authorities could use on future operations. At the same time, the operation put the Bení processing labs of Roberto Suarez in range of Bolivian authorities for the first time.

Perhaps more important, the execution of Operation Blast Furnace marked a milestone in U.S.-Bolivian counternarcotics cooperation and helped expunge the image of Bolivia as a corrupt, drug controlled nation. Because the project required the support of major political institutions in both Bolivia and the United States, it was hailed as a model of future cooperation. Additionally, Operation Blast Furnace is often cited as having forced down leaf prices for several weeks by preventing traffickers and farmers from completing transactions.\textsuperscript{86}

The biggest drawback associated with Operation Blast Furnace was that it took on an air of U.S. military occupation. U.S. military equipment, including Blackhawk helicopters and cargo planes, was extremely visible in the jungle regions. Though disruptive, Blast Furnace also epitomized the problems of large, intrusive operations. Bolivian public and official support was tested by the visible U.S. presence. Often, raids of laboratories turned up evidence that the facilities had been recently abandoned. Either the traffickers abandoned their facilities in anticipation of a raid, or they were tipped off about operations. Finally, the program was expensive, and maintaining the tempo of operations proved impossible.\textsuperscript{87}

Thus, Operation Blast Furnace was confined to a finite time frame of operation. In addition, the geographic range of operations was confined to Bolivia, since conditions in Peru and Colombia did not permit such programs. Nevertheless, the success of Operation Blast Furnace convinced authorities that a long-term interdiction campaign was needed.\textsuperscript{88} From this thinking, Operation SNOWCAP emerged.

\textsuperscript{86}See Section 4 for more on problems with Bolivian coca price data.
\textsuperscript{87}Operation Snowcap: \textit{Past, Present and Future} (1990), p. 50.
Operation SNOWCAP

SNOWCAP is in some sense a successor to Blast Furnace. It again is a program aimed at source country suppression, but this time it operated in Bolivia and Peru and with an indefinite time frame. SNOWCAP arranged a lower profile in the region by emphasizing host country operations and obligations, and by preparing the host countries through training and assistance.

Operations SNOWCAP set ambitious objectives such as disrupting coca paste purchases through immobilization of paste processors, destruction of paste processing facilities, arrest of wholesale paste buyers, and disruption of their support structure by enhancing the air-mobile capability of the UMOPAR in the Chapare region. Additionally, U.S. authorities sought to develop airlift capability in order to conduct operations against clandestine laboratories and processing centers in remote areas of the country, establish forward operating bases to sustain Bolivian operations in remote areas, and control movement of drugs and chemical shipments along rivers.

In more general terms, Operation SNOWCAP was designed to enhance the ability of the Bolivian government to conduct special investigations leading to major seizures, arrest, and successful prosecution of major traffickers and key lieutenants, as well as augment the capability of the Bolivian National Police criminal investigation elements to identify and trace drug-generated funds in the Bolivian financial system.

In November 1990, a Red Zone in the Chapare was designated and targeted for disruption. Land, air, and riverine assets were used to target all phases of production. In addition, the program resulted in the successful insertion of UMOPAR (Mobile Rural Patrol Force) agents into the Chapare. Prior to then, UMOPAR did not maintain a regular presence in the area. The operation also temporarily closed three municipal leaf buying centers at Isiboro, Isinuta, and Eteramasama.

Similar objectives were planned for Peru as well, but the dangerous working environment combined with the fragile economy have limited options. As such, the primary objective in Peru has been to

89 Colombia did not participate in Operation Snowcap.
expand the air-mobile capability of Peruvian counternarcotics forces in order to increase operations against the growing number of drug processing centers, and to establish forward operating bases to facilitate operations in remote areas of Peru. Operation SNOWCAP established Tingo Maria as the Peruvian base of operations. Since the flight radius from the town was 60 miles, a second base was established deeper in the jungle. Thus, Santa Lucia became the second counternarcotics base, operating with the same 60-mile radius. Even with a base of operations in the middle of trafficking country, the 60 mile radius proved too confining. Thus, the United States supported the establishment of FARPs, forward arming and refueling points, to allow operations to extend deeper into the jungle.

SNOWCAP had the objective of reducing imports of cocaine by 50%. But as recently as 1989, authorities estimated that they interdicted less than 1.5% of the paste, base, and cocaine produced in Bolivia, and less than 1% of these products in Peru. Table 2.6 reports on some other measures from SNOWCAP operations. Reports indicate that the traffickers have simply extended operations deeper into the jungle in response to law enforcement pressure.

Operations in Peru, for example, now extend further north out of the Upper Huallaga Valley, into the areas around Juanjui and Campanilla.

Despite the low interdiction rates, authorities cite a number of success indicators, including higher prices and lower cocaine purity in the United States during 1989 and 1990. Reports have surfaced that the traffickers have resorted to recycling processing chemicals, a switch ascribed to shortages induced by SNOWCAP. In addition, officials also point to a change in processing laboratories from large, sophisticated facilities to smaller, single dwellings with limited production capacity.

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92 Stopping the Flood (1990), p. 3.
Table 2.6

SNOWCAP Operations for 1990

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labs Destroyed&lt;sup&gt;a&lt;/sup&gt;</td>
<td>159</td>
</tr>
<tr>
<td>Aircraft Seized</td>
<td>48</td>
</tr>
<tr>
<td>Cocaine Seized (MT)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>61.7</td>
</tr>
<tr>
<td>Cost of Operations</td>
<td>$7263</td>
</tr>
<tr>
<td>($thousands)</td>
<td></td>
</tr>
</tbody>
</table>

Note:  <sup>a</sup>Cocaine and base labs.  <sup>b</sup>Cocaine and cocaine base.  Source: Drug Enforcement Administration and the 1991 Andean Interdiction Operations.
3. THE STRUCTURE OF THE MODEL

MODELING PRODUCTION AND POLICY

The previous sections outlined the process of cocaine production and the structure and implementation of source country control policies. This section establishes the framework in which the impact of policy on the cocaine industry can be examined. It should be obvious from the previous sections that a number of factors will influence the production of cocaine at a given time and that the cocaine industry can exert control over some of these factors. The availability and flow of labor into the cocaine industry, for example, affects the production of cocaine, and the industry in turn regulates the flow to some extent through the wages it offers. Some of these influences, however, are external to the operation of the industry, and not directly controlled by the cocaine trade, government policy being perhaps the most important example.

Less obvious, however, is how simultaneous changes in several influencing factors will affect market performance. Frequently, forces can push the industry in opposite directions at once. Without a consistent framework that quantifies the impact of multiple changes, assessments of the cocaine industry’s response to environment cues are reduced to speculation. Hence the need for a model.

Modeling essentially involves representing behavior in the form of equations. Increasing the number of lines and equations will increase the number of behavioral elements ‘explained’ by the model, but it will also increase the chances of encountering odd and unexplainable hills and valleys in the system of equations and lines. Complicated models often generate results that exceed our ability to understand intuitively. Additionally, complex models require more data, a commodity difficult to come by in the illicit world of narcotics. For these reasons, the model presented below is relatively simple.

Despite being a relatively simple model, the representation of the cocaine trade presented here marks an advance over previous attempts to
model policy's impact on the cocaine trade.\footnote{Previous efforts to model the cocaine production process and international control programs include: Kennedy, Reuter, and Riley (1993a and 1993b); Wuestman (1990); Greenfield (1991); Reuter, Crawford, and Cave (1988); and Godshaw, Koppel, and Pancoast (1987).} Perhaps the most consequential feature is that the model is dynamic, to account for the inherent lags in the production, export, and smuggling processes. Accounting for the lags between policy and response not only gives a more accurate picture of policy's impact on cocaine production, it also provides a better understanding of the time horizon over which policy will have its effects.

This model features additional distinctions as well. Among them are the incorporation of inventory behavior and wage differentials, as well as more detailed representations of both the policy environments and the policies considered.

**Types Of Economic Output**

Economic output in BCP comes in two distinct forms. First, there is traditional economic output, constituting Gross Domestic Product (GDP). GDP includes activities like making cars, producing computers, and so forth. This economic activity is captured in official statistics. The laborers employed in the production of such goods pay taxes, the government tracks production and sales of such items through surveys of economic activity, sales taxes, licensing, and other monitoring devices, and most output is governed by various forms of government regulations. In this model, the output of traditional GDP is designated Q and parameters and variables that relate to the production of Q are subscripted \( q \). The BCP economies contain a second type of distinct economic output, cocaine.\footnote{A third type of economic output, that of the underground economy, is ignored as an unnecessary complication. The underground economy involves the illegal production and sale of legal commodities. The manufacture of moonshine is one such example from history, and the Andean economies, particularly Peru, are replete with thousands of examples. For more on the underground economy, see de Soto (1989). For more on why this market can be ignored in the analysis, see Kennedy, Reuter, and Riley (1993).} Unlike formal economic activity, the output from the drug sector is not a legal good. Of course, other
illegal goods are produced in BCP, including drugs such as marijuana. The effects of other illegal production, however, are ignored, in part because they pale in comparison to the effects of cocaine production. The scope and operation of the cocaine economy will be indexed with the variable $C$ and the subscripting $c$.

Combined, these 2 economic activities are taken to represent the total of all economic activity in BCP.

**Legal Economic Output ($Q$)**

$Q_{t,i}$ is legal GDP produced in time period $t$ in country $i$. To accommodate the maturation cycle of coca plants the time horizon ($t$) used is six months. Hence, the production of legal GDP is written:

$$Q_{t,i} = A_{q,i} * L^{a_{q,i}}_{t,i} * K^{1-a_{q,i}}_{t,i}$$  \hspace{1cm} (1-3)

for $i=1-3$ (Bolivia, Colombia and Peru), which says that output ($Q_{t,i}$) varies as a function of the factor inputs labor ($L_{q,t,i}$) and capital ($K_{t,i}$)$^3$ and the share of national income each factor earns ($\alpha$ and $1-\alpha$).

**Cocaine Sector Output**

Cocaine production is modeled differently than formal sector output. For cocaine production, capital does not need to be formally modeled. It is assumed that because of the low level of technology involved in cocaine production and because of the illegal nature of cocaine production and the subsequent need to shift production locations frequently because of law enforcement concerns, that all capital specific to the production of cocaine is fully depreciated in one year. More permanent capital equipment, such as planes for transportation, are subject to confiscation but are of low cost relative to the value of production. Thus, they too are depreciated over the one-year horizon.

Instead, cocaine production depends in large part on the amount of land devoted to coca farming ($N_{t,i}$).$^4$ Land relates to the output of

$^3$Capital is not indexed by $q$ because capital is used only in the legal sector.
cocaine in proportions that vary by country, region, and type of coca. In the legal sector, it is sufficient to describe a general trade-off between labor and capital across the spectrum of industries. The generalization is adequate for representing all legal economic activity in BCP in part because legal economic activity is not the focus of the analysis. The Cobb-Douglas generalization, however, is not an adequate tool for representing the cocaine industry.

Constant Elasticity of Substitution (CES) production functions are more appropriate for analysis of the cocaine industry. CES production functions allow \( \sigma \), the elasticity of substitution between factors of production, to assume a value other than one.\(^5\) It is important to use a value other than unity in the analysis since the factors of production, land, and labor do not substitute for each other with ease. The expression for the production function, and thus cocaine output is (for \( i=1,..3 \)):

\[
C_{c,i} = A_{c,i} \left[ \alpha_{c,i} L_{c,i}^{-\rho_i} + (1 - \alpha_{c,i}) N_{c,i}^{-\rho_i} \right]^\frac{1}{\rho_i}
\]  
(4-6)

where:

\[
\rho_i = \frac{1-\sigma_i}{\sigma_i}
\]

A lower elasticity of substitution would indicate relatively less substitution occurs between land and labor, while a higher value for \( \sigma \) indicates relatively easier substitution. Low elasticities of

\(^4\)Land is not indexed by c because land is not used in both the legal and cocaine sectors.

\(^5\)Cobb-Douglas production functions are simply a special case of the CES class. See Arrow, et al. (1961), pp. 225-250; and Henderson and Quandt, "Chapter 3: The Theory of the Firm," (1971) for a technical exposition on CES production functions. In the case where \( \sigma \) approaches 1, \( \rho \) approaches 0 and the CES generalization simplifies to Cobb-Douglas behavior.
substitution carry certain implications for the cocaine industry. Perhaps the most important consideration is that if the price of an input rises, there is little ability to substitute in another input. Thus, the only way to maintain profit levels is to pass along the cost increase to the consumer. Since counternarcotics policy in BCP is intended to raise prices, if the elasticity of substitution used is lower than the actual elasticity of substitution, the model will have overstated policy’s impact.

The second consideration is that the drug industry will seek to locate itself in areas where all factors of production are relatively inexpensive. It is not sufficient to locate in an area where one of the factors of production is relatively inexpensive if the second, more expensive factor, cannot be substituted for easily. In theory, this implies an ability to force up the production costs of the industry by constraining one factor of production. In other words, to be effective, policy need only make one factor of production scarce or unavailable.

Data on the appropriate rate of substitution between land and labor is limited. Studies of U.S. agriculture in Florida show $\sigma$ to be highly variable across time and crops, while studies of less capital-intensive countries such as Sri Lanka and India show $\sigma$ to be around .5. The value .5 corresponds well with intuition and field observations that even under high rates of land removal, and thus intense pressure to substitute labor in to maintain production, it is very difficult to use more than three times as much labor on a given plot of land. At the same time, some substitution is possible: more labor can be used to ensure a more thorough harvest, or used to process coca leaf longer to extract more of the alkaloids from the leaf.

**LAND**

The production of cocaine begins on the farm, and as such, land assumes a fundamental role in this model. There are a number of aspects about land’s role in the cocaine production process to consider.

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Perhaps most important is determining the amount of land used in the production process. The amount of land used in the base case was derived in the process of estimating world cocaine supply. The amount of land devoted to coca farming can be expected to change in response to a number of factors. An eradication policy, for example, exogenously changes the amount of land available for coca farming. The amount of land under cultivation will also change as a result of changes within the system. That is, land responds endogenously as profit conditions improve and worsen. To see why this is so, consider what happens when there are changes in the demand for cocaine. If demand for cocaine fell precipitously, the price of cocaine would fall. As the price of cocaine fell, traffickers would offer farmers less for coca leaf. Some farmers would no longer be able to earn a profit, and thus they would exit the occupation. The quantity of land under cultivation, therefore, would fall over time in response to variations in demand and other economic conditions. Similarly, the cost of labor and the subsequent cost of clearing new land relative to the price of the final product and the potential profit is what prevents an unlimited supply of land from being farmed. The most important consideration to keep in mind is that land moves in and out of production in response to economic factors such as price, profit, and the cost of preparation.

Because coca is a perennial plant, decisions about how much land to put under cultivation in one time period affect revenue many periods ahead. Any model that attempts to predict the decision to put land under cultivation must reflect the multi-period effects that such a decision has. A single coca plant can provide harvests, and thus revenue, for up to 30 years. More characteristic, however, yields begin to decline much earlier, and the useful life of the plant rarely exceeds 15 years. For purposes of this analysis, the 15-year harvest life will be used. At the same time a peasant plants a new coca

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9See Appendix in Kennedy, Reuter, and Riley (1993a).
10Plowman (1985).
11Harvests are treated as homogenous and uniform. That is, the quality and quantity of harvests are assumed to be the same throughout the 15 years. One extension of the analysis will consider whether
field, and thus provides himself with a new source of revenue for 15 years, he also incurs development costs. Establishing the new field requires an investment of labor and time.\textsuperscript{12}

In general, the decision of how much land to keep under cultivation reflects an assessment of the risks and uncertainties associated with farming. Risks include such factors as weather, natural disasters, and yield variations, while uncertainties might be things like the future of the policy environment, and future preferences for the product being produced. Other factors that might be incorporated into a planting model include technological change, expectations of policy actions, constraints on production inputs, and the heterogeneity or homogeneity of land quality.\textsuperscript{13} In this instance, technological change is ignored, because the production of coca is simple and the capacity for technological change among the farmers is low.\textsuperscript{14} Policy expectations or anticipation will be explored in sensitivity analysis. It is assumed that no significant constraints on the availability of production inputs, in particular land, exist.\textsuperscript{15} Finally, the quality of modeling harvests that decline with age combined with the known age of the plant stock lead to different results.

\textsuperscript{12}These costs would all be incurred at the time the land was readied for cultivation. Over the life of the land, other costs associated with maintaining the land stock (as opposed to the costs of production) might be incurred. Such costs, which are likely to be very small, and therefore which are ignored in this report, would include additional work that needed to be done to prevent erosion or soil nutrient depletion. Rather than attempting to factor in these costs separately, they are embedded in the assumed average useful lifetime of the plant itself. Hence, while some fields might in fact suffer nutrient depletion to the point where they were no longer cultivatable, it is assumed that a rural coca farmer, without recourse to fertilizers and machinery, but with recourse to other land, would simply abandon the field.

\textsuperscript{13}Day (1963), pp. 7-8; and Moore (1969), pp. 8-10.

\textsuperscript{14}One technological advance, the processing of cocaine in a solution form known as aguarica, will be explored in a later section that addresses inventory accumulation.

\textsuperscript{15}See Alberts (1983) for more on land availability in Peru and Heath (1969) and Zonas de Produccion por Cultivos y Subregiones (1992) in Bolivia.
the land is assumed homogenous and yields constant, since data on these subjects are scarce and coca plants grow well in poor conditions.

The above elements combine to determine the amount of land, \( N_t \), available at a given time \( t \) in country \( i \). Formally,

\[
N_{t,i} = N_{t-1,i} - E_{t,i} - R_{t-1,i} + 3.33 \delta N_{t-2,i} + 3.33 \delta N_{t-3,i} + 3.33 \delta N_{t-4,i} \quad (7-9)
\]

In words, this means that the supply of land in production in country \( i \) at time \( t \) equals the amount of land from the previous period \( (N_{t-1}) \) less both eradications \( (E_{t-1}) \) and land stock retirements \( (R_{t-1}) \). Land put under cultivation \( (\delta N_{t-1}) \) does not become productive until six months after planting \( (\delta N_{t-2}) \), and then only partially. The equation reflects the fact that land provides only partial harvests until 24 months after planting by spreading out productive capacity over three six-month periods \( (\delta N_{t-2}, \delta N_{t-3} \text{ and } \delta N_{t-4}) \). Eradication is imposed as exogenous shocks to the system, while retirements from the original stock occur at a rate of \( 1/15 \) of the stock per year.\(^{16}\)

The decision to plant is a function of the price, revenue, and cost associated with coca farming. Specifically, planting \( (\delta N) \) if

\[
\sum_{t=1}^{10} \left[ \frac{1}{(1 + r)^t} \right] \cdot \left[ \frac{P_t \cdot (N_{t-1,i} + \delta N_{t-1,i} - R_{t-1,i}) \cdot \tau_t \cdot \omega_{t,i} \cdot \gamma_t}{N_{t,i}} \right] > h_i \cdot \omega_{t,i}.
\]

In other words, the decision to plant more land is positive if the sum of the discounted net revenues from an additional acre of cultivation exceeds the costs associated with preparing the acre. The discounted net revenues are equal to the product of the expected future price of leaf \( (P_t) \), the new total acreage under cultivation \( (N_{t-1,i} + \delta N_{t-1,i} - R_{t-1,i}) \), and the amount leaf \( (P_t) \) that the acreage under cultivation would produce, less the wage bill associated with cultivating the new acreage at a rate of \( \omega_{t,i} \) labor units per hectare.

\(^{16}\text{This reflects the 15-year productive life of an average coca plant.}\)
Revenues are discounted at a rate of 20% to incorporate the farmers’ strong preference for cash over potential revenue in the form of coca stock.\textsuperscript{17}

The discounted net revenues must exceed the cost of preparing a new hectare for cultivation ($h_l \times w_{l,i}$) per hectare, where $h$ is the amount of labor in man years it takes to clear one hectare and $w_{l,i}$ is the wage rate that prevails at the time of planting.\textsuperscript{18} Unlike the revenues, which arrive in a flow over 15 years, all preparation costs are assumed incurred in the year of planting, and thus no discounting is required.

From the available literature, $h$ is estimated to be 1.25 man years per hectare, meaning it would take one farmer working full-time 1.25 years to prepare a hectare for cultivation.\textsuperscript{19} Equivalently, it would take 5 farmers working full-time only 3 months to prepare one unit of new land. At first, these numbers might not make intuitive sense because they lead to unexpected results. For example, at the rate implied by $h$, it would take less than 150,000 people to replant all of the acreage currently under cultivation in Peru, a number which is less than 37% of the estimated size of the labor pool involved in producing cocaine. If land is so easy to bring under cultivation, why aren’t there thousands more people engaged in the activity? Two explanations for this dichotomy surface. First, in absolute terms, coca farming is

\textsuperscript{17}So far as is known, no estimates of coca farmers’ implied discount preferences exist. The rate used in the calculations, however, indicates a strong preference for current income over potential income, a fact that is consistent with the literature on peasant agricultural economies. See Rhoades and Bidegaray (1987); Browman (1987); and Andean Peasant Economics and Pastoralism (undated).

\textsuperscript{18}In the case where the marginal cost of planting is constant, a knife’s edge solution results. That is, the decision is either to plant nothing or plant an infinite amount because the discounted revenue either never or always exceeds the discounted costs. This problem can be avoided by imposing increasing marginal costs on the model. However, it is not clear in this case that marginal costs do rise over the relevant production range since the supply of useable land is virtually unlimited and the land used in coca farming is often of poor quality in remote, isolated regions. To avoid the knife’s edge solution, then, farmers are assumed to stop planting at the point when marginal revenue nearly equals marginal cost.

\textsuperscript{19}Morales (1990); Kennedy, Reuter, and Riley (1993a).
not highly profitable. Rather, coca production is profitable in relative terms to other crops. Cocaine distribution is profitable because the distributors assume much higher risks, such as receiving a prison sentence in the United States and greater violence at the highest levels of the trade. Farmers receive less than 1% of the street retail price of cocaine for their farming efforts. Second, the farming itself is very labor intensive. Every hectare under cultivation requires more than two full-time laborers per year, compared to less than one worker for other crops. To the extent that coca farming is still carried out on a subsistence basis at the family level, individual producers may not have sufficient resources to greatly expand production.

In addition it is necessary to determine the leaf price in order to complete the equation. Under rational expectations theory, a farmer correctly forecasts the future price of coca on the basis of current information and past experience. Coca has transformed parts of Bolivia and Peru from subsistence agriculture to cash economies, and the existing marketing networks ensure that farmers are aware of current coca leaf prices. In addition, the farmers are also aware of the factors that influence leaf prices. In the past, law enforcement operations have succeeded in temporarily depressing leaf prices in the short run, while over the long run, leaf prices seem to have fallen in response to chronic oversupply. Therefore, it is not unreasonable to assume that farmers will be aware of fluctuations in local leaf market prices. Because the farmers accurately forecast leaf prices, they know whether current marginal costs of preparing new cultivation for production exceed the future price. If revenue at the expected price exceeds the marginal cost, the farmers will expand production up to the

---

21Lucas and Sargent (1981); Muth (1961).
22Prices in Bolivian markets, for example, are posted on a daily basis and are widely communicated throughout the Chapare.
point where the values are equal; if revenue is less than marginal cost, no planting occurs.

The expected future price of leaf is a function of the price of cocaine, and the price of cocaine is a function of the demand for cocaine. Demand for cocaine can be represented as a function of price:

\[ D_{t,c} = c \times W_t^\xi \]  \hspace{1cm} (10)

where \( \xi \) is the world street price elasticity (hereafter street price) of demand for cocaine, \( c \) is a scaling constant, and \( W_t \) is the world street price of cocaine. In reality, there is no single world street price. Prices within the United States depend not only on where the transaction takes place, but the form in which the drug is sold (cocaine or crack), the volume of the transaction, and numerous other factors. Instead, the street price should be taken to represent the aggregation of the individual demand curves that govern these smaller markets.

The street price is in turn a function of the wholesale export price \( (P_t) \) and an exogenous markup \( (MU) \):

\[ W_t = P_t + MU \]  \hspace{1cm} (11)

Substituting the right side of equation 11 into the demand equation, we get:

\[ D_{t,c} = c \times (P_t + MU)^\xi \]

which says that the demand for cocaine is determined by the export price \( (P_t) \) plus a markup \( (M) \), scaled by a constant \( (c) \) and the price elasticity of demand \( (-.5) \). Demand must equal the supply. Expressing supply in terms of land, we find:

\[ S_{t,c} = \sum_{i=1}^{n} \left( \frac{1}{\xi_i} \right) \times F_i \times N_{t,i} \]  \hspace{1cm} (11a)
where \( f_i \) is the rate at which leaf yields cocaine alkaloids in country \( i \), \( F_i \) is the rate at which land yields coca in country \( i \), and \( N_{t,i} \) is the amount of land under cultivation at time \( t \) in country \( i \). The amount supplied by any one country, then is:

\[
S_{t,i} = \left( \frac{1}{f_i} \right) \times F_i \times N_{t,i} \tag{11b}
\]

Since demand equals supply, we therefore know:

\[
D_{t,c} = \sum_{i=1}^{k} \left( \frac{1}{f_i} \right) \times F_i \times N_{t,i} \tag{11c}
\]

which can be rewritten to find the wholesale price:

\[
P_t = \left( \frac{D_t}{c_t} \right)^2 - MU \tag{11d}
\]

Substituting eq 11b for \( D \) in eq 11d we get:

\[
P_t = \left( \frac{1}{f_i} \times P_{t,i} \times N_{t,i} \right)^2 - MU \tag{11e}
\]

Now, the wholesale price of cocaine \((P_t)\) must equal the value of leaf in the wholesale product plus the production cost \((pc)\) for each country \( i \). The value of leaf in wholesale cocaine is simply the price of leaf \((P_{t,i})\) multiplied by the cocaine content of a country’s leaf, \( f_i \); the balance is production costs \((pc)\).

\[
P_t = (P_{t,i} \times f_i) + PC_i
\]

Substitute for \( P_t \) from equation 10e to get:

\[
P_{t,i} = \frac{\left( \frac{1}{f_i} \times P_{t,i} \times N_{t,i} \right)^2 - MU - PC_i}{f_i} \tag{11f}
\]

This formula expresses the price of leaf as a function of the amount of land in production. This entire expression for the price of leaf gets
substituted into equation 10 to yield the final formula that determines the amount of land planted, δN, at time t.

\[ \sum_{t=1}^{10} \left[ \frac{1}{1+\gamma t} \right]^{\zeta} \left[ \frac{\left( \frac{\delta N_{t+1} - \delta N_{t-1}}{\delta t} \right)^{\gamma}}{\delta t} \right]^{\eta} \frac{(\delta N_{t+1} - \delta N_{t-1})^{\gamma} \delta t}{\delta t} \cdot \delta \tau_{t,i} \cdot \epsilon_i \]

\[ h_i \cdot \delta \tau_{t,i} \]  

(12-14)

WAGES AND EMPLOYMENT

Total Employment

Total employment \((L_{0,i})\) in this model is endogenous for any given country but is assumed to grow at an exogenous rate. The labor used in planting \((\delta N)\) is used at the beginning of the period and is therefore not available for allocation between the cocaine and legal sectors. Thus,

\[ L_{0,i} - L_{\delta N,t,i} = L_{A,t,i} + L_{C,t,i} \]  

(15-17)

where \(L_{0,i}\) is the initial total labor force size in country \(i\), \(g\) is the rate of population growth and \(t\) is the time period over which the population growth takes place.

Wages and Sectoral Employment

To determine employment in a given sector, it is necessary to explicate the marginal output conditions. Under conditions of perfect competition and profit maximization, the wages paid to workers are equal to the marginal product of labor. Whenever these assumptions hold, the the general wage-marginal product formulation holds for both the legal and cocaine sectors:
\[ w_{q,c,i} = \alpha_{q,i} \times A_{q,i} \times K_{t,i}^{\alpha_{q,i} - 1} \times L_{t,q,i}^{\alpha_{q,i}} \]  

(18-20)

for the legal sector or:

\[ w_{c,t,i} = \frac{1}{p} A \left[ \alpha_{c,i} L_{c,t,i}^p - (1 - \alpha_{c,i}) K_{c,t,i}^p \right] \frac{1 - p}{p} (-p) \alpha_{c,i} L_{c,t,i}^{1-p-1} \]

for the cocaine industry. The wages between the two sectors are linked by the expression:

\[ w_{q,t,i} = \frac{w_{c,t,i}}{(1+b)} \]  

(21-23)

where (1+b) is the premium associated with undertaking illicit coca farming and cocaine production. The premium is initially assumed to be 0, but will be varied to see if the cocaine industry's ability to offer higher wages affects the impact of policy.

This equation can be rearranged to solve for the amount of labor used in both the legal and cocaine sectors:

\[ L_{t,q,i} = K_{t,i} \times (\alpha_{q,i} \times \frac{A_{q,i}}{w_{t,i}})^{1/(1-p)} \]

\[ L_{t,c,i} = \left[ \left( \frac{w_{c,t,i}}{\alpha_{c,i} A_{c,i} P_{t,i}} \right)^{1-p} - \alpha_{c,i} \right] \left[ \left( 1 - \alpha_{c,i} \right) N_{c,t,i}^p \right] \].

These equations summarize the wage rate paid and the amount of labor demanded, respectively for the legal and cocaine sectors, respectively.

The amount of labor used to place land under cultivation is derived from the number of hectares of new land cultivated, \( \delta N \), and the
number of workers per hectare it takes to ready a hectare for
cultivation in country $i$. This is expressed as follows:

$$L_{t,\delta N_{i}} = h_i \delta N_{t-1,i}$$  \hspace{1cm} (24-26)

The Capital Stock

The capital stock in this model is exogenous. Capital accumulates
at an exogenous rate in the BCP economies, over and above the rate of
depreciation. In addition, however, the drug trade destroys some
capital in an effort to influence government policy decisions. Thus, at
any given time the amount of capital available for use in the legal
sector is:

$$K_{t,i} = (K_{0,i} \times k^t)$$

where $K_0$ is the original capital stock and $k$ is the rate at which
the stock grows.

WORLD SUPPLY AND DEMAND FOR COCAINE

The model is closed out with a picture of how the cocaine products
are disposed of on world markets. The world cocaine market is in
equilibrium when world supply of cocaine equals world demand. From
equations 4-6, production of cocaine in a given country is simply:

$$C_{t,i} = A_{c,i} \left[ \alpha_{c,i} L_{c.t.i}^{-\rho} + (1 - \alpha_{c,i}) N_{t,i}^{-\rho} \right]^\beta.$$

Thus total world cocaine production is simply the sum of the above
equation across the $i$ countries:

$$S_{t,c} = \left[ \sum_{i=1}^{n} A_{c,i} [\alpha_{c,i} L_{c.t.i}^{-\rho} + (1 - \alpha_{c,i}) N_{t,i}^{-\rho}]^\beta \right].$$  \hspace{1cm} (27)

Initially, the desired level of inventory is assumed to be zero to
focus on the impact that policy has on production. However, in
subsequent sections, the desirability of holding inventory will be considered.

Finally, the model is closed by stating the equilibrium condition that cocaine supply equals cocaine demand:

\[ S_{t,c} = D_{t,c} \]  

(28)

The equations numbered 1-28 form a complete system that allows the relevant variables of interest to be determined. Table 3.1 summarizes the 28 variables in the order they appear in the model.
Table 3.1
Summary of Model Variables

<table>
<thead>
<tr>
<th>NAME</th>
<th>VARIABLE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENDGENOUS VARIABLES</td>
<td></td>
</tr>
<tr>
<td>$c_t.i(3)$</td>
<td>Output (GDP)</td>
<td>$\text{millions}$</td>
</tr>
<tr>
<td>$c_t.i(3)$</td>
<td>Cocaine output</td>
<td>metric tons</td>
</tr>
<tr>
<td>$n_t.i(3)$</td>
<td>Coca farming area</td>
<td>hectares</td>
</tr>
<tr>
<td>$n_t.i(3)$</td>
<td>Planting area</td>
<td>hectares</td>
</tr>
<tr>
<td>$L_{q,t,i}(3)$</td>
<td>Legal employment</td>
<td>thousands</td>
</tr>
<tr>
<td>$L_{c.t,i}(3)$</td>
<td>Cocaine employment</td>
<td>thousands</td>
</tr>
<tr>
<td>$w_{t,q,i}(3)$</td>
<td>Wage rate (legal)</td>
<td>$\text{dollars}$</td>
</tr>
<tr>
<td>$L_{pl,t,i}(3)$</td>
<td>Planting employment</td>
<td>millions</td>
</tr>
<tr>
<td>$D_e(1)$</td>
<td>World cocaine demand</td>
<td>metric tons</td>
</tr>
<tr>
<td>$S_w(1)$</td>
<td>World cocaine supply</td>
<td>metric tons</td>
</tr>
<tr>
<td>$W_t(1)$</td>
<td>Street price of cocaine</td>
<td>$\text{dollars/KG}$</td>
</tr>
<tr>
<td>$P_t(1)$</td>
<td>Wholesale cocaine price</td>
<td>$\text{dollars/MT}$</td>
</tr>
<tr>
<td></td>
<td>EXOGENOUS VARIABLES</td>
<td></td>
</tr>
<tr>
<td>$L_{e,i,t}$</td>
<td>Total labor available in country i</td>
<td>thousands</td>
</tr>
<tr>
<td>$M_u$</td>
<td>Mark up to street price</td>
<td>$\text{dollars/KG}$</td>
</tr>
<tr>
<td>$E_t.i$</td>
<td>Eradication area</td>
<td>hectares</td>
</tr>
<tr>
<td>$R_t.i$</td>
<td>Plant stock retirements</td>
<td>hectares</td>
</tr>
<tr>
<td>$K_t.i$</td>
<td>Capital stock</td>
<td>$\text{billions}$</td>
</tr>
<tr>
<td></td>
<td>PARAMETERS</td>
<td></td>
</tr>
<tr>
<td>$\alpha_i$</td>
<td>Legal productivity index</td>
<td>N/A</td>
</tr>
<tr>
<td>$\beta_i$</td>
<td>Cocaine Productivity Index</td>
<td>N/A</td>
</tr>
<tr>
<td>$\alpha_i$</td>
<td>Output elasticity of labor in country i</td>
<td>N/A</td>
</tr>
<tr>
<td>$\alpha_i$</td>
<td>Output elasticity of capital in country i</td>
<td>N/A</td>
</tr>
<tr>
<td>$c$</td>
<td>Cocaine Demand Scaling Index</td>
<td>N/A</td>
</tr>
<tr>
<td>$F_i$</td>
<td>Land-to-leaf conversion in country i</td>
<td>hectares/mt</td>
</tr>
<tr>
<td>$f_i$</td>
<td>Leaf-to-cocaine conversion in country i</td>
<td>mt/mt</td>
</tr>
<tr>
<td>$g$</td>
<td>Rate of labor population growth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SUBSCRIPTS</td>
<td></td>
</tr>
<tr>
<td>$i$</td>
<td>Country index</td>
<td>N/A</td>
</tr>
<tr>
<td>$c$</td>
<td>Cocaine industry index</td>
<td>N/A</td>
</tr>
<tr>
<td>$q$</td>
<td>Legal economy (GDP) index</td>
<td>N/A</td>
</tr>
<tr>
<td>$t$</td>
<td>Time period index</td>
<td>N/A</td>
</tr>
</tbody>
</table>
4. RESULTS OF MODEL SIMULATIONS

This section presents the results of model simulations in four parts. The first part describes the base case that provides a summary of the dimensions, structure, and operation of the cocaine economy and how it influences the national economies of BCP. Thus, subsection one is a view of how the cocaine economy might evolve in BCP in the absence of any policy pressure. It is a view of the world as it exists today and how it is likely to evolve under very specific conditions.

Parts two and three impose changes on the base case. In all instances, the base case is used as the comparison metric. Part two is a look at the effects of coercive source country control policies on the production of cocaine, including eradication and interdiction. Part three assesses volitional policies, including voluntary eradication and development assistance. Each of the policies examined in parts two and three is broken down into constituent elements: effectiveness, industry response, and implementation. The effectiveness sub-subsections summarize a policy’s impact on the production and export of cocaine under optimal conditions of implementation. The industry response sub-subsections detail the steps the traffickers can take to evade or vitiate the policy’s impact. The implementation sub-subsections outline the obstacles to optimal conditions for policy implementation and discuss the consequences of sub-optimal conditions for policy effectiveness.

Finally, the fourth part of this section will consider global modeling and data issues that transcend individual policy scenarios. Thus, this portion of the section will address such modeling issues as the structure of demand and the consequences of the price markup structure, as well as inventory accumulation and a cocaine sector wage premium, for the efficacy of policy.

THE BASE CASE

This subsection summarizes the basic dimensions and parameters of the cocaine industry, as depicted in the model. The cocaine production
data used in the model are from 1989. Although these are not the latest available data, they offer a number of advantages over more recent data. First, other RAND research has already been completed using the 1989 cocaine production data.\(^1\) Continuing the use of the 1989 data provides a convenient comparison benchmark to previous work. Second, since there is such tremendous disagreement over the size of the cocaine trade, the data used are in some sense arbitrary. One of the values of the analysis lies in discovering how sensitive the model is to the parameters and data fed into it, not the exact production results of any one simulation. Indeed, one purpose of the modeling efforts is to determine the marginal value of more accurate data.

For the base case, then, the model was calibrated to yield 740 metric tons of cocaine. This amount represents the estimated 1989 combined production total for BCP.\(^2\) It does not, however, include estimates for other world production. Similarly, the estimate does not represent what happens to the cocaine after it is exported from BCP to the United States. That is, the estimate does not account for U.S. domestic interdiction and other losses that occur after the final stage of production. Rather, the emphasis is on production capacity.

### A Portrait of Production

These production estimates can be thought of in two ways: the amount of cocaine or cocaine product produced in a specific geographic location or the amount of cocaine produced from intermediate goods of a specific origin. The former case is the one usually considered. Colombia produces most of the world's cocaine, even though it produces little of the intermediate goods needed to make the final product. Colombia accomplishes this by importing the intermediate goods and manufacturing them into the final product. In contrast, most of the cocaine manufactured in the world comes from Peruvian sources. More specifically, Peru produces approximately 60% of the world's coca leaf,

\(^{1}\)Kennedy, Reuter, and Riley (1993a).

\(^{2}\)Based on estimates contained in International Narcotics Control Strategy Report (1989) and reported in Kennedy, Reuter, and Riley (1993a).
making Peru accountable for roughly 60% of global cocaine supply. Table 4.1 summarizes the two forms of production figures, and Table 4.2 shows the income generated from the industry.

Table 4.1
Cocaine Production in Bolivia, Colombia, Peru

<table>
<thead>
<tr>
<th>Country</th>
<th>Cocaine Exports</th>
<th>Total Cocaine Yield from Leaf Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peru</td>
<td>15</td>
<td>412</td>
</tr>
<tr>
<td>Bolivia</td>
<td>86</td>
<td>259</td>
</tr>
<tr>
<td>Colombia</td>
<td>639</td>
<td>69</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>740</strong></td>
<td><strong>740</strong></td>
</tr>
</tbody>
</table>

Table 4.2
National Income Generated by Stage of Cocaine Industry

<table>
<thead>
<tr>
<th></th>
<th>Peru</th>
<th>Bolivia</th>
<th>Colombia</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf</td>
<td>309</td>
<td>95</td>
<td>23</td>
<td>427</td>
</tr>
<tr>
<td>Paste</td>
<td>142</td>
<td>171</td>
<td>3</td>
<td>316</td>
</tr>
<tr>
<td>Base</td>
<td>189</td>
<td>161</td>
<td>106</td>
<td>456</td>
</tr>
<tr>
<td>Cocaine</td>
<td>45</td>
<td>128</td>
<td>1342</td>
<td>1515</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>685</strong></td>
<td><strong>555</strong></td>
<td><strong>1474</strong></td>
<td><strong>2714</strong></td>
</tr>
</tbody>
</table>

NOTE: Figures in $millions.

Although the cocaine trade generated approximately $3 billion in regional economy in 1989,\(^3\) the industry’s output had an estimated street value of $99.9 billion.\(^4\) The vast majority of the value added in the cocaine industry arises as a result of distribution beyond the borders.

\(^3\)This estimate excludes any value added generated by BCP nationals in the retail end of operations. The model in effect assumes that all import and street retail activities are handled by non-BCP nationals. *Latin American Newsletters*, Confidential Report 1 (1990) reports that estimates of the amounts returned to BCP may be exaggerated.

\(^4\)Assuming an average street price of $135 million per metric ton. This price assumption is maintained throughout the analysis, as this was the prevailing street price in 1989. This figure should be regarded as potential revenue, since many transactions will take place at prices lower than the prevailing street price. Frequent users, for example, often buy in large quantities and may therefore receive quantity discounts.
of BCP. Production and export constitute a relatively small share of value added in comparison. Another way to illustrate the same point is to trace a kilogram of cocaine from production to its ultimate street destination, keeping track of prices and revenues along the way. Table 4.3 follows this trail.

Table 4.3

<table>
<thead>
<tr>
<th>Raw Price of</th>
<th>Kg required to</th>
<th>Value of input required</th>
</tr>
</thead>
<tbody>
<tr>
<td>kg input</td>
<td>make 1 kg cocaine</td>
<td>to make 1 kg cocaine</td>
</tr>
<tr>
<td>Leaf</td>
<td>$2</td>
<td>$708</td>
</tr>
<tr>
<td>Paste</td>
<td>$350</td>
<td>$1,085</td>
</tr>
<tr>
<td>Base</td>
<td>$1,675</td>
<td>$1,843</td>
</tr>
<tr>
<td>Export Cocaine</td>
<td>$3,870</td>
<td>$3,870</td>
</tr>
<tr>
<td>Street Cocaine</td>
<td>$135,000</td>
<td>$135,000</td>
</tr>
</tbody>
</table>

NOTE: Using Bolivian prices and conversion ratios.

Table 4.3 reveals some key points about the structure of the cocaine trade. International control programs are aimed at affecting the costs and prices of the cocaine industry up through wholesale exported (noted by the double line in Table 4.3). Yet the table clearly illustrates that there is very little leverage associated with these stages of production. For example, suppose law enforcement pressure led to a doubling or tripling of the raw price of leaf, leading to a doubling or tripling of production costs associated with that stage of manufacture. Even if the entire burden of this cost increase was passed along to the consumer on the street, the street retail price would price would barely move.\(^5\) In the event that leaf prices tripled and the costs were completely passed along, the street retail price would move from $135,000 per kilogram to $136,408 per kilogram, or a 1% increase. Consumption would decline less than 1% because the price elasticity is less than unity.

Table 4.3 shows that there is slightly more leverage at the wholesale export stage of production. But again, even if prices at this

\(^5\)Caulkins (1990) has developed alternative models of price markups, and these are considered later.
stage of production tripled, the street retail price would rise from $135,000 per kilogram to $142,740 per kilo. While such a policy would result in a nearly 6% increase in street prices, the effect on consumption would still be small.

The weak impact that international drug control programs have on street retail prices may not obviate the utility of such programs. The policies would remain useful insofar as they cause permanent disruptions in output, or insofar as short-run interruptions of supply can be integrated with other aspects of drug control strategy. The weak impact also implies that the policies need to be of large scale. Massive movements in source country prices will be required to affect demand even modestly at the street level. International programs also may make more effective use of resources than domestic programs. Domestic law enforcement programs, for example, involve disrupting transactions between 6 million users and 240,000 dealers\(^6\) over a geographic range that encompasses the entire United States. In contrast, international export control programs target smaller numbers of high-level traffickers, perhaps numbering in the tens of thousands, along narrower geographic ranges that define trafficking corridors. The costs of source country control programs might be substantially lower than control programs in the consuming because the wages of source country officials are substantially lower. The costs of operating in remote, isolated regions might offset some of this wage cost advantage, however.

Finally, there is the argument that controlling drug production at the source leads to lower program costs downstream. Less drug production means reduced need for domestic control and treatment programs. Thus, while the odds may appear to be stacked against source country programs, they also should not be rejected a priori.

A Dynamic Portrait

The above section provides a static picture of the cocaine industry. It is a snapshot of the industry at a point in time. Over time, however, both the legal and the cocaine sectors change. Capital

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\(^6\)Using the assumption from Reuter and Kleiman (1986), p. 294, of 25 customers per dealer.
stock accumulates, the labor pool grows, and the economy responds to these factors. This leads to the need to understand how events will unfold not only in the time period in which the policy act is completed, but in subsequent time periods when the policy's effects and the counter strategies used to respond to policy implementation play themselves out. Just as there are limits or parameters to the speed and efficacy with which policies can be implemented, there are also limits to the ability of the policy target to adapt its behavior to the policy. The incorporation of these lags or delays results in a dynamic model.

One implication of dynamic markets is that there are constant changes in the markets, even if no policies are imposed. And indeed, this is the case with cocaine. One way in which cocaine markets are likely to change over time relates to the amount of land under cultivation. Without any exogenous shocks to cocaine markets, the amount of land devoted to coca farming varies as plants age and lose their productive capacity. Even if the farmers collectively planted exactly the same amount of land that was lost to retirements, the coca yield, and thus the amount of cocaine produced, would still change because of the lag between planting and the attainment of full productive capacity. Moreover, the farmers never plant exactly the amount of land taken out of production because they have imperfect knowledge of cocaine and coca markets. To the extent that they anticipate market changes incorrectly, they will plant too little or too much land, inducing further variations in cocaine output.

Figure 4.1 shows the variations in coca plantings and cocaine output that take place without external shocks to the system. These variations are a function of the aging of the plant stock and decisions that the farmers make about placing more land under cultivation. Every six months, approximately 6500 HA of coca are retired because of age. Since the demand for cocaine is assumed to remain constant in the base case, the farmers must plant at least that much coca to maintain

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The variation in coca planting decisions over time is consistent with behavior in other agricultural sectors. See Trivedi (1992), Greenfield (1991), and French, King, and Minami (1985) for a more detailed discussion.
production. The fact that, commencing with the first planting cycle, the industry’s productive stock is composed of plants with varying yields induces further variability into planting patterns. As the mix of age, and thus yields, changes over time, the farmers continuously have slightly too much or too little stock on hand to meet demand and seek to adjust productive capacity through planting behavior. Finally, the growth in the legal sector generates some of the variability in planting patterns by competing with the coca sector for resources.

As coca planting and the size of the coca stock vary over time, so does the output of cocaine. The variation in cocaine output is less than the variation in planting and the size of the coca stock because the amount of labor used in the cocaine industry varies over time. When the stock of coca is relatively low, the industry uses relative more labor to compensate, which in turn allows the output of cocaine to remain relatively stable.

In subsequent subsections of the analysis where the effects of policy changes on cocaine production are considered, the natural variation will be presented so that a more accurate assessment of the policy’s impact on cocaine production over time can be obtained. The natural rhythm to cocaine production is called base production trajectory, and the cycle inherent to planting is called base planting trajectory.
Fig. 4.1—Base Production and Planting Trajectories

Changes also occur in other parts of the economy, primarily because capital stock is added and the labor force grows. If there are no changes in the demand curve for cocaine—that is, the demand curve retains its shape and location—then as the capital stock and labor force grow and opportunities in the legal sector expand, the production of cocaine begins to drop. Base production trajectory denotes these vacillations in production over time. Production drops because over time, given no other changes in the cocaine industry, the cost of producing cocaine increases. The growth in legal sector capital stock increases labor’s marginal product. Since labor is paid a rate equal to the value of the marginal product, an increase in the capital stock bids up wages. The cocaine industry suffers a permanent increase in its cost structure because it must offer higher wages to remain competitive. Thus, as the capital stock increases, wages and costs in the cocaine industry rise and it is possible, in effect, for a country to ‘grow out’ of cocaine production.
This is the good news. The bad news, however, is that this process is extremely slow. Over the course of a 15-year adjustment period, where no changes occur in cocaine demand, cocaine output declines less than 1%, while regional GDP grows almost 74% and regional employment grows nearly 36% (see Table 4.4).

Table 4.4

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NOTE: Price in $ per kilogram; GNP in $millions; cocaine output in metric tons; labor in thousands; wage is composite across countries. Figures reported on a six-month basis.
The exercise of looking at economic growth's impact on the production of cocaine illustrates the point that the cocaine industry is affected by changes in the overall economy in which it is embedded. To be effective, a policy must not only act relatively quickly, but permanently, by causing significant and lasting reductions in production. Economic growth, it would appear, is a very inefficient tool as far as reducing the production of cocaine, but the logic behind economic growth's impact on output underscores the logic behind the search for other policies that will reduce the production of cocaine. However slowly the economic growth works, it has its effects by raising the cost of cocaine production relative to other economic activity. In effect, the search for other viable policies is a variation on the growth theme: how can the costs of production be raised sufficiently to curtail demand?

COERCIVE POLICIES

One of the most direct ways of raising the costs of production is to raise the risks, uncertainties, and penalties associated with drug production. These strategies can assume a number of forms, from seizure of assets and more effective prosecution of traffickers to shutting down processing sites, stepping up interdiction efforts, and forced eradication.

This subsection analyzes two general forms of coercive policies, eradication and interdiction.

Only source country interdiction is considered here. That is, the analysis does not consider interdiction at the U.S. border. Other works, most notably Cave and Reuter (1988), Crawford and Reuter (1988), and Reuter, Crawford, and Cave (1988) have investigated interdiction's effects at this stage in drug trafficking. Among other changes, analyzing interdiction at the U.S. border would require modifying the fixed markup from wholesale to retail price to reflect the factors that go into determining retail prices. Under the fixed markup formulation, the traffickers expect a known and unvarying level of law enforcement effort against them at the retail level.
coca leaves. It involves destruction of labs, incarceration of participants, and interdiction of processing chemicals. Similarly, eradication may also be construed as policies aimed at preventing resumption of farming activity on land after eradication. The second reason why these programs are considered is because it is virtually impossible to conceive of an international drug control program that does not contain some elements of eradication and interdiction; they compose the foundation of international drug control programs.

It is also important to note what this analysis does not examine. This analysis does not, for example, consider chemical control and refinery destruction programs, nor does it consider aggressive arrest, prosecution and 'kingpin' or 'decapitation' programs intended to cripple the leadership of the cocaine industry. Nevertheless, there are elements of the model and the analysis that have strong implications for these unexamined programs. For example, assumptions about the availability and interchangeability of labor and the mobility of processing labs have strong implications for labor-based programs and refinery destruction programs. If these factors are readily available, and easily replaced or relocated, it is doubtful programs that target these links in the production chain can have their desired effects. In the present analysis, however, these must remain implications since the programs themselves are not explicitly considered and modeled.

Two types of coercive policies will be considered, for a total of four different coercive scenarios. The first type of policy will affect the industry during one production period; the second type will be applied against production in every time period. These are known as, respectively, shock and periodic policies. The purpose behind imposing two different forms of the same policy on the model is to demonstrate how the cocaine trade will respond to both policies that shock the production cycle and policies that are applied more frequently, and thus become a more integral part of the production horizon.

Existing source country control policies tend to be oriented toward the periodic type. Of these, some are fairly regular in their execution. For example, quarterly fulfillment of eradication targets leads the United States to release balance of payments support funds to
Bolivia. In contrast, other programs such as interdiction depend on
surprise and are much less predictable. However, while it is true that
any one interdiction raid or mission might be a shock, the overall level
of interdiction activity tends to take on the character of periodic
policy: funding levels tend to remain relatively constant or grow in
known proportions, counternarcotics forces are staffed at relatively
stable levels, and institutions and organizations tend to have fixed
assignments. Even the metaphor "War on Drugs" connotes a long term
campaign. Nevertheless, shock campaigns such as Operation Blast Furnace
in Bolivia are not unknown.

SHOCK ERADICATION

Effectiveness of Shock Eradication

Successful eradication of 50% of the coca crop would substantially
curtail cocaine production in the short run. Initially, leaf prices are
bid up as refiners compete for the smaller quantities of leaf being
produced. The higher leaf costs force up the prices on intermediate
goods such as paste and base, and these price effects work all the way
up the production chain to the price at the street retail level, which
in turn dampens the demand for cocaine. Figure 4.2 shows that cocaine
production drops from 370 MT to approximately 233 MT in the six months
of eradication. Even though eradication takes place only in the first
six months, output continues to fall into the second six months because
of additional plant stock retirements.
Fig. 4.2—Cocaine Output Under Shock 50% Eradication

Several interesting factors emerge from a closer look at the policy’s impact on markets and production. First, output does not decline in strict proportion to the amount of hectares eradicated because the traffickers are able to compensate for the reduction in land by applying more labor. In the case of farming, the peasants would begin to harvest leaves more carefully and begin to market lower quality leaves,\(^9\) and, in the case of refining, the drug lords would make attempts to extract more cocaine from the leaves.\(^{10}\)

Second, it is important to distinguish the impact that the policy has on prices for the various intermediate goods. Prior to policy implementation, the wholesale export price of cocaine stood at roughly

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\(^9\)Lower quality leaves require more processing for lower yields.

\(^{10}\)The longer the leaves are processed, the more paste, and thus cocaine, they yield. It is not clear what the yield curve looks like, and how much is gained by extra hours or days of processing. Nevertheless, according to reports, processors often will not bother to process leaves for more than a few hours in an effort to get the paste out in a timely manner. Coca Cultivation and Cocaine Processing: An Overview, p. 9.
$4 million per metric ton but climbed to over $209,000 million per metric ton after eradication. The street retail price climbed from $135,000 per kilogram to over $340,000 per kilogram. In terms of proportions, the street retail price increased by more than a factor of 1.5; yet wholesale cocaine prices increased by a substantially larger factor. Thus a policy that proves phenomenally effective at moving the prices of intermediate goods still has a much smaller proportional impact on overall production and demand. In absolute terms, the impact on production can be quite substantial.

The “success” of raising the prices of intermediate goods also masks an important consequence of policy implementation. Raising the price of coca leaf also increases the rewards associated with coca farming, and thus the very policy that forces the farmers to quit the business also substantially rewards them for reestablishing production elsewhere. The higher leaf price serves as a signal to the farmers, and as a result they place more land under cultivation. As the new plantings enter the production stream, output of cocaine rises and the price for cocaine drops accordingly. Figure 4.2 shows the impact of the increased levels of farming activity. By the third period, the new cultivation yields output and production begins to recover. By the second year after eradication, farmers have brought sufficient new land under cultivation to completely neutralize the effects of eradication.

Table 4.5 shows what happens to some other pertinent indicators. In particular, it should be noted that eradication and the consequent turmoil in cocaine markets inspire significant labor movement throughout the region. Cocaine employment peaks at approximately 3 million, a 3.5-fold increase from the pre-policy level. The mobility of labor is, in part, guaranteed by the notable increases in wages that occur.11 Eradication causes a 11% increase in wages in the first and second periods as the cocaine industry bids for the services of desperately needed labor. As the impact of eradication recedes, wages fall to a lower level, before beginning to rise again in later years in response to capital stock growth.

11Wages are calculated as a weighted composite from Bolivia, Colombia and Peru.
Table 4.5
Impact of 50% Shock Eradication

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</tr>
</tbody>
</table>

NOTE: Price in $ per kilogram; cocaine output in metric tons; labor in thousands; wage is composite across countries. Figures reported on a six-month basis.

With the rise in cocaine output and the fall in cocaine prices, the future earnings associated with coca farming also fall. Gradually, then, the price of coca leaf settles back down, and the farmers continue planting, but only at a rate sufficient to replace the stock lost to retirements. Figure 4.3 shows the pattern of planting over the 15-year period.
Industry Response to Shock Eradication

In the short run, there is little the traffickers can do to counter eradication because the cultivation sites are fixed. The most effective short-run strategy, therefore, is to apply more labor to maximize output from the remaining crop. This means, for example, more careful harvests of the plants so that all the usable leaves are cultivated, and more careful processing of the harvest so that as much of the cocaine alkaloids are extracted from the leaves as possible. Other attempts to counter eradication in the short run are possible, such as security against manual eradication teams, protective covering against aerosol forms and aerial delivery of herbicides, and manual efforts to collect herbicide pellets before they leach into the soil.

Over the medium run, the farmers may begin to conceal new cultivation in response to eradication. Currently, most of the cultivation in Bolivia and Peru takes place in the open, with little effort to hide cultivation from law enforcement officials. In Peru,
camouflage is not typically necessary since law enforcement officials maintain only a weak presence in the primary coca cultivation regions. In Bolivia, law enforcement efforts against illegal cultivation and diversions of legal production to illegal markets are similarly weak. Concealment efforts could range from replanting off the roadway in the back acreage on existing farms to replanting under the protective cover of other vegetation to conceal coca plants from aerial surveillance. Alternatively, the farmers could begin cultivation on virgin tracts of land in an attempt to evade regional eradication. Finally, the coca industry could also respond by moving cultivation out of BCP and into surrounding countries, such as Brazil, Venezuela, Ecuador, and Argentina. While the act of eradication is not necessarily any more difficult in these countries, the political barriers to implementing eradication in these nations would be formidable. It has taken over a decade of concerted efforts by Washington, D.C. just to convince the Bolivian and Peruvian governments to support eradication programs tepidly. It is difficult to imagine that the United States could persuade additional nations to allow full-scale eradication without a similar exertion of effort.

**Implementation of Shock Eradication**

Successful eradication of 50% of the BCP coca crop would mark a tremendous improvement over current voluntary and previous forced eradication efforts. From a technical and practical standpoint, eradication of 50% of the coca crop is probably feasible, particularly given the availability of herbicidal eradication as an option. After all, much coca farming currently takes place in the open, so authorities have relatively certain knowledge about the location of cultivation areas. However, given intelligence, reconnaissance, and other limits, as well as the remote locations and rugged terrain around many coca farms, 50% eradication probably represents the practical upper limit to eradication, short of complete defoliation of the region.

Despite the conceptual simplicity of the idea, eradication would not be an easy task. The herbicides used in chemical eradication kill by being absorbed up through the root system of plants. When the
herbicide accumulates in sufficient quantities in the plant, it inhibits photosynthesis. Once photosynthesis has been blocked, the plant dies.

Three factors determine the rate of absorption, and thus the rate at which plant life will be killed. First, irrigation is vital to absorption. However, too much water dilutes the herbicide and pushes it below the plant's root zone. Second, the soil texture helps determine absorption by affecting how long the herbicide persists in the soil. Longer persistence leads to greater absorption. Generally, loose, sandy soils provide lower persistence because they allow the herbicide to sink below the root structure. Finally, the application rate will be a factor in absorption. The higher the concentration, the greater the persistence and absorption.

To reduce the risk of dispersal, these herbicides can be applied in pellet form. Once on the ground, the pellets leach into the soil during rainfall. At first, grasses that occupy the top soil layer and have very shallow root zones die. As the herbicide continues to work its way into the soil, plants with deeper root zones are affected. Similarly, as the treatment settles out of the topsoil layer, plants with shallow root zones grow back. Regrowth of plants with deeper root systems is possible, depending on how long the herbicide persists below the topsoil layer. Immature plants, for example, could survive until their root systems extended into the deeper layers where they might be killed by chemicals persisting beneath the surface.

Tests that reported on the effects of commercial herbicides may have ignored some potential complications of widespread eradication. Specifically, the tests, which included visual inspections of plant mortality and soil measurements of persistence, concluded after three months. Larger plants, particularly those with deeper root systems, may not be affected by herbicides for a year or more. Thus, the tests may have underreported the risk of collateral damage to other vegetation.

In short, eradication is difficult to control with any certainty. Some variables, such as precipitation, are beyond control, while others, such as soil characteristics, cannot be reasonably quantified because of

the remoteness and extremeness of the environment. At best, herbicidal eradication would be extremely imprecise and would pose a substantial risk of collateral damage to other plant species. Manual eradication remains an untenable alternative because of substantial logistical and security problems.

PERIODIC ERADICATION

Effectiveness of Periodic Eradication

Figure 4.4 shows the results of a policy under which 50% of the acreage is eradicated every six months. In the first six months of such a policy, cocaine production falls to 233 metric tons, from 370 metric tons in the base case. This result parallels the shock eradication outcome. Also during the first year, farmers begin to react to the government's policy. As coca becomes scarce and the price rises, farmers are encouraged to place more land under cultivation because the present value of the revenue stream from a new hectare exceeds the cost of preparing the hectare for use. Although farmers respond by planting more coca, cocaine output falls even more in the second period as eradication continues. Production declines to around 112 metric tons as 50% of the remaining coca stock is eradicated in period 2 and new cultivation has yet to become a factor. By the third period, cocaine production begins to climb as land put into cultivation in previous periods begins to provide harvests. By period five, production levels off at a rate substantially below that of the pre-policy level.
The periodic eradication program described above works to reduce permanently the output of cocaine for two specific reasons. First, eradication takes place at a pace that overwhelms the rate at which new plantings become part of the production stream. Thus, although over 176,000 hectares of land are placed under cultivation in period 1 in response to eradication, if this acreage is eradicated at the 50% rate, only 22,000 hectares of it will enter into the production stream 3 years later.

The second, more important reason, why output falls permanently under the scenario described is that the farmers never anticipate eradication using the original modeling assumptions. Under the original specification of the model, eradication is, in effect, a surprise every year. Repeated, surprise eradication leads to an approximately 67% lower equilibrium level of production, and the short-run result of the shock scenario becomes the long-run result of the annual operation.

Given the difficulty in concealing eradication efforts and the corruption that pervades the region, farmers would likely have prior
knowledge that a threat to their operations existed. In short, the farmers would anticipate at least some eradication. Determining how much of the eradication the farmers are able to anticipate is, of course, a subjective exercise. In general, coca farming is a very competitive business, and thus the market is well informed about relevant influences. In addition, it is difficult to conceal forced eradication. It is likely that such operations would be very visible to the local population. Finally, drug traffickers, who have an interest in maintaining production, would help inform the coca markets as well.

The anticipation of eradication increases the amount of land farmers will place under cultivation. To see why, return to equations 12-14 in section 3, which show that the decision to plant is a function of the marginal revenue of land.

$$\sum_{t=1}^{30} \left[ \frac{1}{1+\tau} \right]^t \ast \left[ \frac{\left(\frac{1}{2} \ast f_t \ast (N_{t-1,i} + \delta N_{t-1,i})}{c_i} \right)^{-2} \ast \left( \frac{1}{2} \ast \left( N_{t-1,i} + \delta N_{t-1,i} - R_{t-1,i} \right) * f_{t,i} - w_{t,i} * v_i \right) \right]$$

$$h_i * w_{t,i}$$

As the amount of land in production decreases, the marginal revenue of the land remaining in production increases. When farmers anticipate eradication, then instead of basing their planting decision on the $N_{t,i}$ hectares from the previous period available for production in the current period, they will base their planting decision on the fraction of the $N_{t,i}$ hectares they expect to survive eradication. A smaller number of surviving hectares leads to a correspondingly higher level of planting. Figure 4.5 presents the outcome of a 50% eradication program where the farmers anticipate most, but not all, of the eradication effort.
Figure 4.5 shows that anticipation substantially reduces the 'shock' benefits of periodic eradication. Unanticipated eradication, 3% in this example, accounts for most of the gap between production in the base trajectory scenario and production under eradication in the later years. Note also that the farmers can overestimate eradication, thereby stimulating more production than would occur in the absence of policy intervention. Because of the high probability that eradication will be anticipated, the balance of the analysis ignores outcomes with no anticipation.

**Industry Response to Periodic Eradication**

Periodic eradication appears to disrupt cocaine production in the same way a shock eradication program does. That is, the policy causes a temporary disruption in production that is followed by the industry's adaptation to the policy and a resumption of pre-policy patterns of production. At first glance, then, the policies would not appear to
offer much choice in that they lead to similar outcomes. In fact, however, there are changes beneath the surface that require consideration.

The difference between the policies lies in the amount of land cultivated and the amount of labor employed under each policy. Under a policy of a one-time eradication shock, the market is temporarily disrupted and farmers respond by placing new land under cultivation, but only enough to return to the original amount of cultivation in the long run. In contrast, if eradication occurs every period, the farmers again place new land under cultivation, but at a much higher rate than under the shock policy. The rise in cultivation under periodic eradication occurs because the peasants begin to compensate for the land that they lose to eradication every period. Figure 4.6 shows the difference in the amount of land under cultivation under a shock eradication policy and a constant eradication policy.

![Diagram showing Coca Planting under Constant and Shock Eradication]

**Fig. 4.6—Coca Planting under Constant and Shock Eradication**
A similar pattern emerges with respect to employment. Constant eradication consumes the most labor because the farmers cultivate more land. The shock eradication program uses the least amount of labor because the farmers face no shortage of land after the first period. Thus, except for the spike in employment after the shock, labor use in the shock scenario does not deviate substantially from the base trajectory case.

![Graph showing labor use under constant and shock eradication](image)

**Fig. 4.7-Labor Use Under Constant and Shock Eradication**

In general, then, periodic eradication causes more disruption than shock eradication. That is, periodic eradication causes the most displacement of labor and the most changes in the levels of farming activity. Thus, periodic eradication is likely to profoundly affect local and national migration patterns and result in higher levels of employment in the cocaine economy. Similarly, periodic eradication is more likely to result in greater levels of farming activity, which may contribute to further environmental degradation, deforestation, and so forth in the region. In exchange for these higher levels of resource
use, periodic eradication offers the prospect of having a greater lasting impact on cocaine production than shock eradication, depending on how well eradication policies are anticipated.

Implementation of Periodic Eradication

Periodic eradication, like shock eradication, poses substantial implementation problems. In fact, the problem with periodic eradication is multiplied by the need to continue the program over multiple time periods. Assuming that the 50% periodic rate of anticipated eradication is maintained over time, the periodic policy has substantively the same impact as the shock policy. In the long run, output returns to approximately the same level under both policies. In terms of efficiency, then, the shock policy beats the periodic policy across a number of dimensions. First, a shock policy would prove substantially less costly to implement because the associated costs of eradication would only be incurred once, rather than on a periodic basis.

Second, shock eradication is likely to cause much less ecological damage and local disruption. In terms of direct ecological damage, the issue is obvious: shock eradication would confine herbicide use to one six month period; periodic eradication would extend the eradication indefinitely. Less obvious, but equally important is that periodic eradication accelerates the rate of cultivation as farmers attempt to stay ahead of the eradication process. The expanded level of farming under periodic eradication can be expected to contribute significantly to local problems with deforestation and clear cutting, as well as chemical pollution of streams and rivers from cocaine processing.\textsuperscript{13}

There is another, more ominous factor to consider. As was discussed in previous sections, eradication may prove to be a difficult task. Recall Figure 4.6, which showed that under the periodic eradication plan farmers place upwards of four times as much land under cultivation. If periodic eradication fails to reach its target, the traffickers are in a position to substantially increase production.

\textsuperscript{13}See Garland (1987).
Thus, periodic eradication runs the real risk of leaving the cocaine industry with the capacity to rapidly expand production.

It is not difficult to imagine the conditions under which the efficiency of eradication would fail. Over time, for example, the farmers could begin to conceal their farming sites, which would complicate or delay eradication. Moreover, as eradication increased leaf prices in the short run, the value of the product to farmers would increase, and so would incentives for corruption. Information about eradication plans would become a very valuable commodity, and it is stretching the imagination to think that eradication programs would not be compromised over time. The risk of reduced efficiency is therefore another reason shock eradication is preferable over the periodic approach.

The risk of declining efficiency over time can be seen in Mexico’s eradication campaigns. Whereas Mexico’s campaña permanente was marked by cooperation and effectiveness in the late 1970s, by the early 1980s its efficacy had begun to unravel.\(^\text{14}\) By the early 1980s, Mexican eradication operations were beset by three sets of problems.\(^\text{15}\) First, weather not only provided for bountiful poppy crops, but hindered the execution of aerial eradication operations as well. Extreme amounts of rain delayed aerial missions and washed away the herbicide after it was applied. Second, the traffickers began to adapt their operations to the eradication program. Cultivation moved to more distant locations, to much smaller parcels, and to higher altitudes, further complicating eradication operations. Third, management problems erupted, including evidence of high-level corruption epitomized by Mexico’s handling of DEA agent Enrique Camarena’s murder.\(^\text{16}\) Other management issues included extreme difficulty in estimating the area under cultivation, coordination difficulties that limited U.S. involvement in many phases of operations, and lack of adequate verification techniques.\(^\text{17}\) By the

\(^{14}\text{Craig (1985).}\)
\(^{15}\text{Craig (1985); Reuter and Ronfeldt (1992).}\)
\(^{16}\text{Craig (1985).}\)
\(^{17}\text{Drug Control: U.S.-Mexico Opium Poppy and Marijuana Aerial Eradication Program (1988).}\)
mid-1980s, eradication progress had become scarce, and U.S. opinion about the program had evolved to a more skeptical stance:

Despite years of eradication activity and significant bilateral funding, the aerial eradication program has not kept pace with cultivation and, during the past 2 years, it eradicated less than 40 percent of the estimated total cultivation of opium poppy and marijuana. In addition, growers have not abandoned traditional growing areas, providing the frustrating and costly prospect of endlessly spraying the same growing regions season after season.\textsuperscript{18}

Mexican drug production began to increase again even though Mexican-U.S. counternarcotics relations began to improve by the end of the 1980s.\textsuperscript{19} To date, Mexico remains an important supplier of drugs to U.S. markets.

\textbf{SHOCK INTERDICTION}

Interdiction is the second major category of coercive policies applied against the cocaine industry. Shock interdictions are similar to shock eradication. Leaf of course, can be interdicted after it is harvested, although it typically is not because of its low value and because smuggling coca leaf is not viewed as an important crime compared to smuggling cocaine. Leaf traffickers, however, typically know little about the structure and operation of the latter stages of the industry, and thus they are of little value to agents seeking to capture and prosecute high-level traffickers. In general, interdiction targets the later stages of production: paste, base, and cocaine. In the case of both shock and periodic interdiction, success rates of 50\%, will be used. Interception rates of 50\% significantly surpass estimates of current source/country interdiction rates.\textsuperscript{20}

\textsuperscript{19}Reuter and Ronfeldt (1992).
\textsuperscript{20}Reuter and Kleiman (1986) estimate that perhaps 30\% of cocaine shipments are intercepted. These figures, however, include seizures that occur beyond the confines of BCP. When only source country seizures are considered, the seizure rate does not exceed 5\% of production. See for example, Stopping the Flood of Cocaine with Operation Snowcap: Is it Working? (1990).
Effectiveness of Shock Interdiction

Shock interdiction is plagued by many of the shortcomings that limit the effectiveness of eradication. Seizure of 50% of the product results in a less than 50% decline in output because the traffickers respond by processing coca leaf more thoroughly to extract more of the cocaine alkaloids.\textsuperscript{21} However, unlike eradication, where there is a lag of 6 to 24 months between seizure and resumption of production, interdiction does relatively little to disrupt the latter stages of production. Depending on the stage of production, production facilities and inputs are easily replaced after an interdiction raid. Paste processing pits, for example, rarely consist of more than crude holes in the ground, or rudimentary vats constructed from locally obtainable materials. Even base and cocaine processing labs, which typically entail more sophisticated construction, are not irreplaceable. Often, redundant labs are constructed so that processing can be moved in the event of a raid. Finally, the processing goods themselves can be replaced in short order. For example, the traffickers have resorted to recycling processing chemicals and modifying manufacture techniques to surmount shortages of processing chemicals.

Figure 4.8 shows the impact of a shock 50% seizure on the long-term output of the cocaine industry. The impact is similar to that of shock eradication, except that there is no lag to the industry's recovery from interdiction. The pre-policy level of production resumes in the period immediately after interdiction because none of the coca crop is destroyed and because the other lags in the production process are insignificant. Table 4.6 summarizes the other effects of shock eradication in BCP.

\textsuperscript{21}There may be a lag of several weeks as the need to process coca leaf more carefully is communicated back to the paste manufacturers. This adjustment, however, should occur quite rapidly and well within the confines of the six-month periods considered in the model. To achieve a 50% drop in the amount of cocaine reaching U.S. markets, approximately 65% of the cocaine produced must be intercepted to account for the production adjustment.
Output Under 50% Interdiction

Base Production Trajectory

NOTE: Scale does not begin at zero to show detail

Fig. 4.8—Impact of Shock 50% Interdiction
## Table 4.6

**Impact of 50% Shock Interdiction**

<table>
<thead>
<tr>
<th>Year</th>
<th>Street Price</th>
<th>Cocaine Output</th>
<th>Hectares Cultivated</th>
<th>Cocaine Employment</th>
<th>Wage</th>
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**NOTE:** Price in $ per kilogram; cocaine output in metric tons; labor in thousands; wage is composite across countries. Figures reported on a six-month basis.

### Industry Response to Shock Interdiction

Unlike the case of coca farming, where at least one factor of production (land) is fixed in the short run, assets at the processing end of the production chain are much more mobile in the short run. Thus, in addition to being able to supply more labor in the short run to counter the effects of interdiction, traffickers could also take other evasive maneuvers. Some relatively simple changes in production
techniques will drastically reduce the effectiveness of interdiction campaigns.

Anecdotal evidence indicates that refiners adjust production techniques to the threat of interdiction. For example, enforcement authorities report that processing laboratories are moving increasingly farther out into the jungle, out of the operating range of forward operations bases in Trinidad (Bolivia) and Santa Lucia (Peru). In many cases, the refineries are extremely simple, and easily moved. Similarly, a marked increase in nighttime and river trafficking activity has been noted, apparently in response to attempts to limit air shipments of cocaine and cocaine products out of the Chapare. There have also been reports that the traffickers have taken to recycling the processing chemicals used in production and developed alternative processing formulas in response to law enforcement measures against precursor chemicals.

Implementation of Shock Interdiction

Interdiction is an inherently difficult process. As cocaine products pass through the successive stages of processing they become smaller and more compact, yet they become increasingly valuable. Consequently, the traffickers have strong incentives to protect their wares from law enforcement authorities. The tactics used to protect drug shipments may range from violence against law enforcement authorities, to corruption and compromise of interdiction personnel. The illicit, mobile nature of interdiction targets makes it extremely difficult to estimate the size of the target pool, and thus the rate of successful interdiction.\(^{22}\) To be sure, it is probably easier to identify illicit commerce in rural regions of BCP because of the generally lower level of commerce, than it is, say, at the U.S. border where hundreds of millions of passengers and countless millions of

\(^{22}\)There are significant disagreements over the amount of leaf cultivated, and leaf is substantially easier to count because it is a relatively fixed asset, and because it can typically be spotted through visual inspection. Satellite observation has aided the process of identifying cultivation sites, but it has not eliminated disagreements over the dimensions of the problem.
merchandise border crossings occur annually. Still, routine inspection of all transactions and cargoes would not be possible.

A 50% interdiction rate would entail substantial disruption of the Andean region. At a minimum, such an operation would require many times more personnel than are now committed to interdiction operations. In some cases, unless new personnel are added, an increase in interdiction operations would mean drawing forces away from other regional problems such as the Shining Path in Peru and guerrilla forces in Colombia. What is more important, the pressure would likely dislocate the drug trade to portions of BCP where it is currently not very active. Since drug processing typically takes place in relatively remote locations, the expanded counterdrug forces would need the ability to operate in isolated environments, increasing the length of supply lines. Many operations would take place away from official supervision, elevating the opportunities for corruption. There would also be a visible increase in military and paramilitary forces and equipment.

Politically, an intensive interdiction program is likely to be unpopular. In Bolivia, Operation Blast Furnace provoked criticism because of the heavy U.S. presence and the military operations. It would be difficult to avoid such complications under an intensive interdiction campaign.

PERIODIC INTERDICTION

Effectiveness of Periodic Interdiction

Unlike shock interdiction, the impact of periodic interdiction extends over a number of periods. Assuming the traffickers begin to anticipate interdiction, periodic interdiction has the same long-run impact on cocaine production as periodic eradication. That is, the markets respond to the law enforcement pressure by applying more labor and increasing cultivation of coca. After the lag caused by the delay in obtaining harvests from newly planted fields, production returns to the pre-policy level. Thus, in the long run, interdiction has no effect on cocaine production. Figure 4.9 shows the changes in production over

15 years, and Table 4.7 summarizes the changes in production and other indicators.

Fig. 4.9—Impact of 50% Periodic Interdiction on Cocaine Production
Table 4.7

Impact of 50% Periodic Interdiction

<table>
<thead>
<tr>
<th>Year</th>
<th>Street Price</th>
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<td>372</td>
<td>454,780</td>
<td>1,208</td>
<td>624</td>
</tr>
</tbody>
</table>

NOTE: Price in $ per kilogram; cocaine output in metric tons; labor in thousands; wage is composite across countries. Figures reported on a six-month basis.

**Industry Response to Periodic Interdiction**

The cocaine industry responds to periodic interdiction in the same manner that it does to periodic eradication. That is, the level of cocaine production activity increases as traffickers attempt to satisfy the market. Cocaine industry employment increases sharply as the traffickers attempt to counter the impact of eradication. Similarly,
cultivation increases dramatically as the traffickers attempt to foil the policy's impact.

The industry thus responds to the threat of interdiction by increasing the level of cocaine-related activities. Additionally, the traffickers will seek to undermine the efficiency of policy through adaptive techniques. Thus, just as in the shock interdiction scenario, smuggling routes and methods may change and the level of violence and corruption would probably increase. In 1989-1990 Colombia mounted one of the most intensive, high profile interdiction and law enforcement-based campaigns on record and was rewarded with an upsurge in violence as the traffickers moved to protect their business. Moreover, Bolivia recorded an increase in violence in its primary cocaine processing regions as Colombian traffickers relocated across the border in an attempt to evade the threat of law enforcement.

Implementation of Periodic Interdiction

Sustaining a high rate of interdiction would require a massive policy effort that probably is not feasible. Already, the United States has had trouble securing foreign support for the relatively small source country interdiction programs it encourages. A larger, more disruptive effort would only be more difficult to justify. The drug traffickers, for example, would probably respond to large-scale interdiction with armed force. Colombia has endured the problems associated with trafficker violence for many years, but large-scale interdiction could not only worsen the situation in Colombia, but extend organized violence campaigns into Bolivia and Peru as well. Thus, it is not clear whether interdiction would be as politically destabilizing as eradication since the former primarily affects urban areas and the latter rural regions.

Support in the Andean nations for interdiction campaigns is not firm. In general, social conditions in BCP are marked by more pressing problems, including the threat of guerrilla violence and poverty.

Volitional Policies

Volitional policies are those where the emphasis is not on law enforcement. Instead, volitional programs rely on economic inducements,
such as rewards for not engaging in cocaine production, to discourage participation in cocaine production. At the farm level, voluntary eradication is one such program, while at the level of the national economy, development assistance is another option. In both cases, variations are possible. For example, voluntary eradication can have a coercive component to it. The existing Bolivian voluntary eradication program, for example, offers eradication compensation only for "legal" coca, not for "illegal" coca.\textsuperscript{24} Similarly, crop substitution programs might attempt to discriminate against those that formerly grew coca for use in cocaine production, and new industries created through development assistance might discriminate against those previously employed in cocaine production.

**VOLUNTARY ERADICATION**

**Effectiveness of Voluntary Eradication**

Voluntary eradication works by compensating farmers for abandoning coca production. Presumably, the United States has no interest in compensating farmers who plant coca after implementation of the voluntary eradication program has begun, since to do so would provide an incentive to plant coca strictly for the purpose of receiving eradication compensation.

The voluntary eradication program currently in effect in Bolivia offers $2,000 per hectare eradicated.\textsuperscript{25} Over the average 15-year life of a hectare of coca plants, the plot of land would yield between 17 and 20 metric tons of leaf. Ignoring discounting, the farmer is compensated approximately $100 per metric ton of coca, assuming the land is turned over in the first year of its productive life. If the land is being turned over in its final year of productive life, the farmer is being compensated approximately $1700 per metric ton, given 1.17 metric ton yields per hectare per year.

Immediately, it is clear that the price offered for voluntary eradication will affect the age of the land turned over for disposal.

\textsuperscript{24}See Ley del Regimen de la Coca y Sustancias Controladas (1988).

\textsuperscript{25}Although not all of this compensation is offered as cash, for purposes of this exercise it is being treated as such.
Generally, the higher the price offered, the more willing the farmers will be to turn over land that has substantial productive life left.

Assume for the moment that the price that would persuade farmers to turn over 50% of their acreage can be determined. What would be the effects? In the short run, the impact might be similar to that of shock eradication: coca output would decline sharply. In fact, because the farmers would willingly turn over their acreage for eradication, the voluntary program might be preferable over the forced program because the voluntary program would probably help ease political tensions with the farmers.

Immediately after voluntary eradication, the price dynamic kicks into effect. The marginal value of the remaining coca farms increases and serves as a signal for farmers to place more land under cultivation. The new cultivation works its way into the production stream and the output of cocaine expands. But as cultivation expands, the price of coca declines and farmers again consider voluntary eradication. In other words, the voluntary eradication program operates on the same principles as coercive eradication and has largely the same effects.

**Industry Response to Voluntary Eradication**

The industry’s adaptation to voluntary eradication would depend in large part on the price offered to farmers. A higher price would encourage more farmers to participate and would require a more dramatic industry effort to replace the lost production. A lower price would substantially ease the adjustment burden because fewer farmers would participate, and thus the market would lose less of its productive capacity.

Assuming the policy was introduced as a surprise, the adjustment mechanism would be identical to that of forced eradication. As farmers took land out of production, the remaining participants would use more labor in the short run in an attempt to satisfy demand. At the same time, the removal of land would signal the remaining farmers to place more land under cultivation.
Implementation of Voluntary Eradication

Voluntary eradication is marked by a number of difficulties. Perhaps the most serious problem is how to design the program in a way that would prevent the farmers from investing their cash payment in the establishment of a new coca farm. A second difficulty is in determining which coca plantations would qualify for compensation. New coca, that planted after the voluntary eradication program went into effect, presumably would not qualify for compensation. But in order to determine the age of the coca stock, authorities would need to conduct a census of land in the region, thus adding to the regulatory burden. In the absence of a census, officials would have little ability to distinguish between legal and illegal coca.²⁶

Perhaps the most substantive hurdle is the cost of implementing the program. Assuming authorities wanted to achieve 50% eradication in the short run, they would have to compensate farmers for nearly 100,000 hectares. Moreover, they would have no ability to price discriminate by offering farmers with older stock less money since there is no ability to discern the age of stock past year four. Since each hectare produces 17 to 20 metric tons of coca over its lifetime, farmers would need to be compensated at the prevailing price for all 15 years' potential production. At a prevailing price of $1,800 per metric ton of leaf, the cost of voluntary eradication would top $4.5 billion. And in fact, since leaf prices would rise as farmers turned over their plots, the prevailing leaf price would be substantially higher than $1,800, and the costs of eradication would rise accordingly.

DEVELOPMENT ASSISTANCE

Effectiveness of Development Assistance

The purpose of development assistance is to provide cocaine market participants with profitable alternatives to cocaine production. The higher the rewards of other vocations, the less interest farmers and traffickers will have in cocaine production, all other factors being ²⁶See the discussion in section 2 on eradication in Bolivia for more details.
equal.  

The problem, then is one of how to make other vocations sufficiently rewarding to attract labor. Development assistance attempts to accomplish this by an infusion of capital that raises the marginal product, and thus wage rate, of labor.

Because most of the cocaine industry's labor is employed in coca farming, development assistance programs are often crop substitution or agricultural development programs. The thinking is that capital that develops agricultural alternatives similar to coca farming will better match the skill base of the population and the infrastructure of the region. There is no requirement, however, that development assistance target agricultural alternatives. Industrial development projects remote from coca growing areas, for example, might be planned to lure labor out of the coca zones.

Development assistance works along the same principles as the economic growth scenario outlined at the beginning of this section. The difference is that development assistance is an attempt to speed up economic growth, and thus force up cocaine industry costs, at an accelerated rate.

Unfortunately, the prospects for using development assistance to accelerate the decline of the cocaine trade appear impractical. Recall from Table 4.4 that even though the capital stock more than doubled from approximately $125 billion to over $265 billion, wages grew only 27%, from $548 to $699. The decrease in cocaine production was thus relatively minor, less than 1% from 370 MT to 367.

Part of the reason the impact of the capital investment was so small was that population grew at a 2% rate in the economic growth scenario. Labor growth lowered the marginal product of labor, muting the effects of the sustained capital investment. A development assistance program, however, would probably attempt to infuse the capital in a much shorter frame of time, thereby avoiding some of the

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27There is an implicit assumption that the participants are not in some way pre-disposed to producing cocaine, but rather are economic actors that seek the highest possible reward for their services.

28The Chapare Regional Development Project, while primarily aimed at augmenting agricultural production, was nevertheless established away from the coca regions in an effort to induce labor migration.
effects of population growth. Assuming for the sake of computational convenience that all of the necessary capital investment could be accomplished in one period, Table 4.8 shows how much investment would be required to reduce production by specified amounts.

Table 4.8

<table>
<thead>
<tr>
<th>Desired Output</th>
<th>Capital Stock</th>
<th>Wage ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
<td>---</td>
<td>549</td>
</tr>
<tr>
<td>1% reduction</td>
<td>$79</td>
<td>699</td>
</tr>
<tr>
<td>5% reduction</td>
<td>$1,114</td>
<td>1894</td>
</tr>
</tbody>
</table>

NOTE: Capital stock figures in $billions; wages per six-month period and composite across countries.

A 1% reduction in output would require an investment of approximately $79 billion, and a 5% reduction would require investment of over $1 trillion. Clearly, these are impractical amounts of development assistance. As the new capital stock in the form of factories, farms and other employment opportunities, is put in place, workers become more productive. As their marginal output increases, so do their wages. The rise in wages in the legal sector would draw labor away from the cocaine sector, depressing cocaine output, and increasing cocaine prices. Even though the investment is very successful at raising wages—it more than triples them in the case of the 5% reduction—source country wages are only a small portion of street retail cocaine prices, and street prices therefore change by only a small amount in response to the development. However, as cocaine prices rise, the profits to the traffickers increase, and the traffickers have the incentive to increase production. Therefore, the traffickers bid up wages in the cocaine sector to lure back some of the labor. As labor returns to the cocaine sector, output increases. Thus, the impact of even unimaginable levels of assistance on wages is dramatic but the effect on drug output is relatively small.
Industry Response to Development Assistance

Even if reasonable amounts of development assistance proved to have tangible effects on cocaine production, it is not clear that the investment would represent a solution to cocaine production. The traffickers choose to produce cocaine in BCP primarily because both factors of production--land and labor--are inexpensive relative to other potential production locations. Moreover, because the substitutability of land for labor is low, the traffickers will consistently seek to produce in regions where both factors of production are low cost. If capital development succeeded in raising the costs of production by elevating the wage rate, it is reasonable to expect that the cocaine industry would relocate over time to an area where the factors of production were less expensive. In this case production might move to an adjacent country that offered abundant land and cheap labor. To the extent the traffickers had to develop new trafficking routes and method, and to the extent relations with existing purchasers were impaired by the move, relocation would increase traffickers' production costs slightly. The value of these routes and relations in the final export cost of cocaine, however, is indeterminate.

The second, perhaps more cost-effective option, for the traffickers would be simply to destroy the new capital stock. Destruction of it would prevent marginal productivity from rising. Clearly, the traffickers can commit such acts, although it is not clear that they would choose this option. In fact, to the extent that an infusion of capital increases the efficiency of trafficking operations, the traffickers may opt to leave the development assistance untouched. Industrial development could provide the traffickers with easier access to processing chemicals, while agricultural development, particularly infrastructure, might ease other aspects of drug production such as coca farming and shipment. Traffickers, for example, have been known to use local roads as landing strips.29 Similarly, industrial and agricultural development in the region would increase the availability of processing chemicals.

29Personal communication with USAID official, La Paz, Bolivia, 1992.
Implementation of Development Assistance

Two intractable obstacles limit development assistance's potential contribution to controlling cocaine production. The primary obstacle is political instability and the lack of state authority. It is difficult to integrate development assistance into local economies through governmental means when the state authority lacks legitimacy, or when it faces a severe threat to its survival. Geographic barriers and the consequent difficulties in establishing a social and economic infrastructure are the second impediment to utilizing development assistance.

The impact of political instability varies by country. Conditions are at their worst in Peru, where the Shining Path has a strong presence in rural regions and is increasingly prepared to carry out a campaign of urban terror. Development programs make prominent targets for attack, and the Peruvian government has found it difficult to protect development personnel. Large portions of the Peruvian countryside, including coca production regions, remain beyond government control. Even increasing security forces' presence does not necessarily provide a solution since Peruvian police and armed forces have long had tense, often confrontational relations with the farmers. Moreover, farmers associate the Peruvian development authority, PEAH, with both security forces and the eradication agency, CORAH. Thus, the development authority in Peru is seen as an enemy by a portion of the population it is intended to assist.

Although Colombia is not as severely challenged by guerrilla forces as Peru, Colombia lacks control over its rural regions to a surprising degree. For decades, Colombia has confronted a guerrilla insurgency. Consequently, the state has made very little effort to establish a presence in some parts of the country, virtually ceding control of the territory to a mixture of guerrilla extremists, drug lords, and peasant farmers. Only the United Nations Drug Control Program (UNDCP) has taken on the task of development in Colombia's Cauca-Nariño coca zone. The programs are relatively small and have made

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31 Riley (1993); Hanratty and Meditz (1990).
little headway in reducing Colombian coca production. The UNDCP's focus on infrastructure and services, however, does provide an important institutional base that links the population to government authority.

The political environment for development is probably at its best in Bolivia where the state does not confront a substantial guerrilla movement. Unfortunately, even without the threat of political unrest, the prospects for development assistance in Bolivia are dim because of the extensive geographic and infrastructure barriers present. These same infrastructure and geographic barriers are present in Peru and Colombia as well.\(^\text{32}\) Geography isolates many of the cocaine industry areas. These regions are served by few roads, and those that do exist are often in poor physical condition. At best, there are very small regional markets in the rural regions. Commerce between the major urban centers and rural outposts tends to be much more important than intra-regional commerce, but transporting goods to urban markets from rural regions can take days, during which time agricultural goods can spoil or be damaged from transit over rough roads. The isolation also adds to the expense of transport.

The impact of these limitations can be seen in programs like the Chapare Regional Development Program (CRDP). CRDP, through research and training, has helped Chapare farmers find potentially competitive substitutes for coca, including pineapples, bananas and spices. Beyond the confines of the Chapare, however, these crops cannot return sufficient profit to cover transportation costs and the damage and spoilage that occurs in transit. Within the confines of the Chapare, the market is too small to support extensive farming, diminishing the crops' ability to challenge coca.

**SEPARATE POLICY APPROACHES ACROSS COUNTRIES**

The scenarios outlined in the previous subsections assume that policy is implemented equally across countries. These policy scenarios were useful for illustrating how the cocaine industry is likely to respond to significant policy interventions, as well as for illustrating

\(^{32}\text{Final Report (1987); Hanratty and Meditz (1990).}\)
how the United States might benefit from an expansion of policy efforts. What the equal implementation of policy across countries ignores, however, are the individual interests each country has in combating the drug trade. Colombia, for example, tends to be most concerned with attacking refining and trafficking because these stages of the trade are concentrated in Colombia, and because of the impact these activities have had on Colombia’s social fabric. In contrast, Bolivian policy tends to be more oriented around stemming coca production, because Bolivia is a leading coca farming nation, because the coca farmers, through their agricultural unions, represent a potent political force, and because Bolivia has been relatively immune to the type of institutionalized violence faced by Colombia. In Peru, controlling the drug trade takes a back seat to the problem of guerrilla violence, and hence is less focused on any one dimension of the cocaine trade.

For each country, progress toward the primary counternarcotics goal would be a significant achievement. Moreover, the United States is likely to find less opposition to expanding source country control programs if it explicitly acknowledges that each nation has a differing set of priorities. It is more reasonable to expect Bolivia to contemplate an expansion of coca control efforts than an extensive interdiction campaign both because eradication looms large for Bolivians and because the United States has worked to cultivate support for eradication programs in Bolivia. From Bolivia’s perspective, controlling coca production would be a significant policy achievement because curtailing the coca trade would smooth relations with the United States and increase the prospects for U.S. cooperation on Bolivian economic matters. Additionally, such an achievement would go a long way toward erasing the memory of the corrupt Meza regime and enhance Bolivia’s reputation in international circles.

Colombia, too would benefit from controlling the cocaine trade. The word Colombia is almost inextricably linked with the cocaine trade. A reduction in exports would assist Colombia in its efforts to attract international investment, develop its tourism, trade, and market legitimate Colombian exports. Equally importantly, a diminishment of the cocaine trade would curb some of the political violence in the
country, perhaps allowing the government to turn its attention to other pressing national problems.

To illustrate the potential implications of a differentiated approach to policy, consider a scenario in which Bolivia commits to eradicating 50% of its coca crop, and Colombia attempts to interdict 50% of its cocaine output. Also assume that Peru, beset by internal problems, is unable to mount a significant expansion of counternarcotics programs.

This model is not well suited to examining the changes in market structure that might occur between countries for two reasons. First, the model uses fixed export shares to describe the trade in intermediate cocaine products between countries. This is a conservative assumption, as the rigidity implies that the industry is relatively constrained in its ability to respond to changes in the environment. Second, farmers base their cultivation decisions on domestic, rather than regional coca prices and coca stocks.

These assumptions in the model were made in part as simplifications. Flexible export shares would, for example, complicate the modeling efforts by requiring computation of minimal export cost shares. The assumptions also, however, reflect uncertainty over the factors that govern export shares. Despite large changes in the law enforcement environment over time, export shares have remained relatively stable.\(^{33}\) Clearly, the traffickers face costs of changing export shares because of the risks associated with establishing smuggling routes, hiring new personnel and operating in new law enforcement environments.

With these caveats in mind, it is possible to speculate about what might happen as a result of the scenario outlined above. As coca farming becomes more risky in Bolivia, Bolivian farmers will attempt to move their cultivation to other areas within Bolivia just as they did in the eradication scenarios. A similar phenomenon will happen with respect to cocaine processing in Colombia. Traffickers will attempt to

\(^{33}\)INCSR, various years.
evade law enforcement pressure by moving operations, but primarily in the confines of Colombia.

The real question of interest is, how much of both the leaf production and cocaine refining will move from Bolivia and Colombia to Peru if the law enforcement efforts are sustained? Fortunately for Peru, the movement will be slow in occurring, if it occurs at all. The reason the cocaine industry is slow to adapt between countries is precisely because of the risks associated with modifying export shares.

Consider what happens to paste processing in Peru when Bolivia endures a temporary disruption of leaf production. The pipeline, through which the leaf is processed into paste, in Peru is relatively full because Peru is processing its normal volume of leaf plus an additional increment to make up the lost crop in Bolivia. In contrast, the Bolivian pipeline is relatively empty, even though the Bolivians have redoubled their efforts to make up for the lost crop. From the overall industry’s perspective, it is probably more cost efficient to try to increase the flow through the Bolivian pipeline than to expand the size of the Peruvian pipeline. Increasing Peru’s production capacity would involve establishing new smuggling routes, bribing more officials, and providing more security. These are risky endeavors in part because many of the Peruvians would be relatively inexperienced at these tasks, and novices face much higher probabilities of failure. In contrast, the production capacity exists in Bolivia but is merely temporarily underutilized.

This analysis indicates that there may be fewer benefits to individual countries from differentiated policies than might be expected. Even with sustained law enforcement efforts, individual countries may find that the drug trade responds with internal, rather than international, migration.

GLOBAL MODELING ISSUES

Having evaluated a set of potential source country control policies, it is important to consider how the results are framed by data limitations and modeling assumptions. The point of the analysis is to gain insight into how the cocaine production process responds to policy.
To gain that understanding, however, both the production process and the policies imposed on it must be adequately represented in the model. Important elements of the production process and policies can be modeled in different fashions, using different assumptions. Thus, the final subsection of this section evaluates the effects of changing assumptions about the price mechanisms, lag and recovery times, inventories, and risks and uncertainty for their effects on outcomes.

**Price Elasticity of Demand and Price Structure**

Perhaps one of the most important parameters in this model is the price elasticity of demand. Price elasticity of demand is an indicator of how much demand for a product will change as a function of a change in price, assuming such factors as income, tastes, and preferences are held constant. With most goods, a higher price results in reduced demand, and such is the case with cocaine. What distinguishes cocaine from other goods, however, is the degree to which demand changes for a given change in price. If cocaine is truly addictive, the elasticity may be close to zero, and demand may change by small amounts in response to large changes in price.

Generally, demand for cocaine is considered price inelastic in the short run, more elastic in the long run. That is, given an increase in price, demand declines in the short run but less than proportionately. Over the long run, current consumption is partially determined by past consumption through addiction. A price increase that reduces short-run consumption reduces long-run consumption by a greater amount because those that cannot or do not consume cocaine because of short-run unavailability have a lower chance of flowing into the long-run heavy user category.

The price elasticity of demand used in the scenarios is -.5. This figure was obtained from estimates for alcohol and cigarettes because estimates for cocaine do not exist. Elasticity measures, however, do

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not inform much about the consequences of changes in consumption patterns. One possible change, of course, is that cocaine users will simply substitute a new drug to replace cocaine as cocaine prices rise. Such substitutions may in turn have large implications for social welfare. Substitution of alcohol for cocaine might, for example, lead to aggregate increases in national health care costs and lead to increased substance abuse among high-risk populations such as minors. For now, it is sufficient to be aware of the potential social costs that substitution might entail. In the concluding subsections, an attempt will be made to evaluate whether society would be better or worse off in the face of such changes.

Price elasticity raises a second consideration: the magnitude of impact that policy intervention has on output. The greater the elasticity, the more a given policy will affect production in the short run.\textsuperscript{37} Thus, if the true impact of a 1\% price increase is a 1\% decrease in consumption, then policies that seem impractical or costly relative to the benefits might become more attractive. A 40\% eradication policy would accomplish as much as a 75\% eradication program if the price elasticity were nearer to (-1) than (-.5).

While there is no certainty about the price elasticity used in this model, the value used in the analysis is also on the conservative side. In other words, it is possible that cocaine consumption is even less responsive to price changes than assumed. In that event, source country control programs would have even smaller short-run effects on consumption.

A related issue emerges with respect to the structure of demand. Many of the policy interventions modeled caused the traffickers to accumulate higher levels of productive stock. With these increased stocks, the traffickers can vastly increase output if the efficiency of periodic policies ever fails. The model, however, implies an upper limit to demand that does not fully account for the possibility of significantly increased demand and, thus, may underestimate the potential

\textsuperscript{37}Price elasticity does not affect long-run results.
hazard of using policies that lead to accumulation of the factors of production.

In the model, demand for cocaine is modeled as a function of the street price of cocaine. In turn, the street price of cocaine is a function of a variable price component (the export price of cocaine) and a fixed component (the mark up from export to street price):

\[ D_{c,c} = C \times (P_t + MU)^5 \]

When the efficiency or implementation of eradication falls, the output of coca climbs in the very short run, causing a fall in the export price of cocaine. The street price, however, can fall no lower than the fixed component of the equation. Thus, even if the export price approaches zero, the fixed price component of the equation implies a theoretical upper limit to demand (with respect to these programs) of slightly more than 375 metric tons (see Figure 4.10).

![Export Price vs. U.S. Demand for Cocaine](image-url)

**Fig. 4.10—U.S. Cocaine Demand**
If this assumption reflects the construct of demand accurately, then the policy community would be indifferent between periodic and shock policy choices because the most demand could climb, under any circumstances, would be less than 2% from the present 370 metric tons to 375.4 metric tons per six months. However, if demand behaves differently than modeled, then the right tail of the demand curve may well exceed 375 MT at an export price of zero. As the efficiency of implementation of periodic policies falls, substantially higher levels of cocaine production and consumption could result in the short run. Thus, to the extent that there is uncertainty about the structure of demand, the shock programs are strongly preferable over periodic policies because of the latter’s effect on the cocaine industry’s productive stock over the long run.

One final note on prices. In this model, only the export price of cocaine adjusts endogenously. Recall that the street retail price of cocaine is simply the sum of the variable export price and a constant markup from wholesale to street retail prices. This equation states demand for cocaine as a function of the export price plus some additional (constant) costs of getting a unit of cocaine to retail markets. Other research has shown that if dealers perceive their costs of doing business primarily as a function of the quantities they deal in, then the constant additive markup is appropriate. However, if they perceive their costs primarily as a function of the price of the drugs they deal in, then a multiplicative or proportional markup is more appealing.

Dealers face numerous costs in getting drugs to markets, and there is no certainty about how they perceive their costs. In general, law enforcement measures tend to cause dealers to think of business costs as a function of quantity. The threat of detection by law enforcement officials rises as greater quantities are shipped, or as a greater number of transactions occur, rather than as the value of the drugs rises. Prison sentences for dealing increase at threshold points that depend on the quantities involved, not the price. Other costs tend to

\[ \text{Caulkins (1990).} \]
vary with price, although quantity considerations still come into
effect. For example, the threat of theft may increase with the value of
drugs held (a risk associated with price) but can be countervailed by
keeping smaller bundles that are more easily hidden (a quantity
consideration). Still other costs, such as the task of hiding and
laundering money or bribing officials, may vary with price-quantity
factors like revenue.

Data on the export prices of cocaine are scarce, and thus it is
difficult to compare the markup in the model with the historical
record. Previous work, however, suggests that the markup lies
somewhere between additive and proportional methods. If that is the
case, then the constant additive markup used in this model may
understate the extent to which retail prices change as a function of
changes in export prices in the short run; the long-run results are not
affected by this distinction. Without a better understanding of
dealers' perceptions of price-related and quantity-related business
risks, however, it is not clear that the additive constant markup is
inappropriate.

Industry Lag Times

One of the most important determinants of the impact policy
intervention has on output is the length of time it takes coca fields to
enter into the production stream. The longer it takes, the longer the
impact of the policy on production, and the greater the value surprise
has as a policy tool. According to available estimates, it takes about
18 months from the date of planting to get full output from a coca
field. In addition, it takes farmers several months to locate new land
and prepare it for farming. Combined, then, it takes the coca farmers
approximately two years to recover completely from the shock of a
policy.

It is possible that the assumptions of the two-year recovery
period, called the Standard Recovery Cycle, are too optimistic, and that

39See Kennedy, Reuter, and Riley (1993a) for perhaps the only
published account of export prices.

restoration of coca farming would actually take longer than two years. For example, during a widespread eradication campaign the farmers might not have access to coca seedlings, adding several months to initial harvests. Likewise, if eradication forced the farmers to use less teneable land, the maturation cycle of the plants might be affected. Such situations will be referred to as the Lengthened Recovery Cycle.

Alternatively, the recovery cycle can also be lengthened through policy measures that increase the costs of bringing land under cultivation. The time it takes to locate suitable land can be lengthened in a number of ways. First, authorities can attempt to make land unusable. Herbicidal eradication, for example, would make eradicated land unusable and force farmers to relocate in their search for land. Second, authorities can attempt to make land unavailable by restricting access to it. For example, troops can be inserted in rural regions as a mechanism for preventing migration to new cultivation regions. In either case, the impact would be to increase the amount of time it takes to locate new land and begin new cultivation, and so this scenario is referred to as Lengthened Search Time.

Figure 4.11 combines these three recovery processes—the Standard Recovery Cycle, Lengthened Recovery Cycle, and Lengthened Search Time—into one diagram. Under the assumptions of the Lengthened Recovery Cycle, coca plants flow into the production cycle over a four, rather than two, year period. With the addition of two years to the recovery cycle, it takes one additional year for production to return to the pre-policy level. The return to the pre-policy of production is not delayed the full two years because the additional time it takes to get new coca plants into production helps keep coca prices high in the interim. High prices in turn cause more planting than would occur if new coca came into production sooner. The cumulative effect is to shave some time off the lengthened recovery period.

In contrast, the Lengthened Search Time pushes back recovery a full year. In this scenario, the farmers are unable to plant in the first year after policy implementation because land is not available. Thus, even though coca prices remain high throughout the period, the farmers have no ability to respond. Once new land is located, however,
recovery resumes at the standard rate, and the effects of policy disappear approximately two and a half years after eradication.

![Graph showing cocaine output over time with varying recovery cycles](image)

Fig. 4.11—Cocaine Output Using Varying Recovery Cycles for Planting

**Inventories**

The capacity to produce and carry inventory allows businesses to respond to fluctuations in market conditions. When demand fluctuates, inventories serve as a buffer, allowing firms to meet changes in demand without incurring such costs as lost sales, the reputation for being an unreliable supplier, and so forth. The need to prepare for such consequences has logical extensions to the cocaine industry where the inability to complete a transaction may brand a dealer as a potential informer and the unavailability of drugs may lead to the loss of anonymous street corner customers to other dealers.

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41See Blanchard (1983), Blinder (1986) and (1981), West (1986) and Holt, Modigliani and Muth (1960) for a range of theories on inventory and inventory behavior.
At the same time, carrying inventory may impose substantial costs on manufacturers. Inventory, for example, obligates the business to pay for storage, and increases the threat of loss, spoilage, and theft, as well as the possibility that the goods may never get sold because of a change in demand.\footnote{For more on the costs of carrying inventory, see Holt, Modigliani and Muth (1960), pp. 67-91.} Drug dealers face additional, and not insignificant, potential costs. More inventory held increases the threat of detection by law enforcement officials, as well as increasing the risk that the cache will be stolen. Holding inventory may also increase the risk that the goods will be self-consumed by weak-willed dealers.

The accumulation of inventory has negative implications for the ability of policy intervention to disrupt production and consumption markets. At a minimum, it increases the size of the policy effort needed to ensure the desired level of market disruption. If large amounts of inventory are held, the expense of implementing policy could increase substantially. At the extreme, if policymakers are ignorant of inventory accumulation, then policy intervention may not be able to achieve even short-run disruption of production.

To understand how inventory affects policy intervention, consider a traditional buffer stock model of inventory.\footnote{See Blinder (1986) in particular for more on this model.} Producers desire to keep production relatively smooth because changes in production levels may lead to higher costs. For example, when demand is slack there are costs associated with laying off personnel, or with workers sitting idle. When demand is strong, there are costs associated with overtime, or with hiring and training new workers. These costs have particular relevance to the cocaine economy. Consider, for example, the ability of disgruntled workers to compromise operations, or the risks of hiring new drug operants on short notice.

During these periods of slack demand, inventory is accumulated. When demand rises, or when law enforcement efforts reduce the ability to meet demand out of current production, the reserves are drawn down. Formally, this is expressed:
\[ S_{t,c} = R_{t,c} + I_{t+1,c} - I_{t,c} \]

where \( S \) is the amount of cocaine produced, \( R \) is the demand for retail sales, and \( I \) is the amount of inventory held in the respective time periods. Strictly, the expression as formulated above holds only for cocaine markets, though it can be extended to express inventory behavior all the way down the production chain to coca markets as well.

Some evidence indicates that traffickers may use inventory methods in their business transactions, though it is far from clear to what extent. In recent years agents have found cocaine products stored in a form known as aguarica, or rich water. This product, which is essentially cocaine base or paste suspended in solvents and stored in drums, prolongs the shelf life of the goods by retarding spoilage from the heat and humidity of the jungle. Without the threat of spoilage, the drugs can be stored safely in remote regions of the jungle, away from crowded urban areas where the threat of detection and theft are greater. Discoveries of caches stored as aguarica became more frequent after the imposition of an air cap over the Chapare in 1992 temporarily restricted the traffickers' ability to move intermediate cocaine products out of the Chapare to El Beni for further processing.\(^{44}\) Storage in this medium probably helped smooth out production of drugs, and may account at least partially for the fact that coca leaf prices did not respond as dramatically to the imposition of the air cap as expected.\(^{45}\)

There is also some indication that the traffickers may be increasingly resorting to smaller, mobile, and redundant processing facilities.\(^{46}\) The Colombian crackdown of 1989-1990 made a significant dent in the traffickers' refinery capacity for a short period of time, and this program may have convinced the traffickers that extra capacity at this stage of production is worth the cost. Many of the base laboratories found now are less sophisticated and have less processing

\(^{44}\)Personal communication, DEA, La Paz, Bolivia.
\(^{45}\)Personal communication, DEA, La Paz, Bolivia.
\(^{46}\)Coca Cultivation and Cocaine Processing: An Overview (1991); personal communication with DEA, La Paz, Bolivia.
capacity than the larger facilities raided in previous years. Moreover, some appear to be designed for use on a rotating basis.

At the farm level, there is little indication of inventory activity. Coca leaves, once picked, cannot be stored for more than a few days because they rot in the moist climate. There is little indication that farmers are carrying inventory of coca-producing land. There is no technical barrier to accumulating an inventory of surplus land; if the leaves are not harvested, the plant will not die. On the other hand, given the uncertainty about the size of the coca plant stock, there could well be excess capacity at this stage of production.

An examination of retail prices does provide limited support for the inventory hypothesis. In 1989 Colombian authorities intensified their efforts against the cocaine trade in Colombia. In addition, U.S. border authorities recorded a 30% increase in cocaine seizures over 1988 to nearly a quarter of the amount produced and exported in the base case scenario. 47 Additionally, 1989 also saw the seizure of 20 MT of cocaine from a warehouse in Los Angeles, along with numerous other domestic seizures. 48 Combined, these events should have put extreme pressure on retail prices.

Figure 4.12 shows that street cocaine prices did in fact climb in late 1989 and early 1990, reversing an unbroken decline of nearly three years. From the 1989:Q2 (the second quarter of 1989) trough in prices, the increase to the peak was 58%. Note, however, that the local peak at 1990:Q3 is nowhere near the global peak at 1982:Q1. Also, street retail prices tend to fluctuate substantially, and this complicates interpretation of price movements.

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47 According to EPIC, authorities seized 145 MT of cocaine in 1989, compared to 112 in 1988.

48 There is no single source that records domestic seizures by municipal police forces and other non-federal organizations.
Fig. 4.12-Purity-Adjusted Street Retail Cocaine Prices

Whether the events of 1989 should have raised street prices more than they did is an open question. The best that can be said is that inventories may have had a role in tempering the effects of the 1989-1990 events. Similarly, the crackdown in Colombia and the increase in seizures may have signaled the value of carrying inventory, and may be another reason why technological innovations such as aguarica began to appear when they did. Beyond those speculations, however, the issue of inventory remains an open, and important, research question.

Risk-Related Wage Premium

An implicit assumption of this analysis has been that market equilibria are not influenced by changes in the risk and uncertainty created by law enforcement and other counternarcotics policies. Put another way, it is the relative scarcity of, and competition for, labor that bids up wages in the aftermath of policy intervention. But as policies are imposed across the region, the participants' perceptions of risk might well change, and these changes will be reflected in the
compensation they demand. For example, under an expansive forced eradication program, farmers might well face the loss of their crops, a risk they currently do not face. Therefore, the assumption that only the competition for labor resources determines the wage level might not be valid as the economy transits from a state of low risk for engaging in cocaine production to one of much higher risk for engaging in an illegal activity.

For a number of reasons, coca farming will be the focus of this analytic exercise. Coca farming employs more labor than all of the other stages of cocaine production combined, and labor’s share of production costs is the highest at this stage of production. Thus, any increase in risk at the coca stage of production will not only affect a large share of the sector’s costs, but the largest number of workers as well. Second, it can also be argued that workers in other segments of the coca industry already perceive some element of risk because of the higher law enforcement threats they have faced over time. In contrast, it is unlikely that coca farmers have much notion of law enforcement related risk since it has not emerged as an issue in the past.

Determining how to account for increased levels (or perceptions) of risk in the system is a difficult task, and it is not clear what form the risk premium should take or how it should be introduced into the model. Participants face both direct and indirect risks in completing their transactions, and these risks would emerge at the onset of eradication. Perhaps the largest source of risks is the potential loss of crops, and thus income, to eradication. This risk would be above the natural risk to income and harvests farmers face from

49The drug-related arrest and prosecution rates in BCP are difficult to pinpoint. Sources suggest, however, that the current ability to apprehend and convict for drug crimes is quite low. INCSR, (1990) for example, reports approximately 6,000 drug-related arrests per year in BCP. These are only arrests, however, not convictions. Given the weakness of the criminal justice systems in BCP, it is likely that only a small fraction of those arrested actually serves time (see Riley (1993) and Hanratty and Meditz (1990) and Hudson and Hanratty (1991) for more on the criminal justice systems in BCP and associated problems of prosecution.

climactic and ecological factors such as drought and insects. Also, there is the potential threat that authorities will confiscate the land, or that the farmers will be arrested and prosecuted. Additionally, the farmers might face increased indirect costs such as increased levels of violence in reaction to policy implementation and increased risk of theft as the product increases in value. Even with relatively quantifiable direct costs, it is not clear what risk premium farmers would demand. Indirect risks are even more difficult to assess because of the uncertainty about how the political environment might deteriorate as forced eradication commenced.

In general, wage demands probably rise faster than risk in the drug industry. That is, a unit increase in risk in retail markets (say, the probability of interdiction) will lead to a more than unit increase in wage demands. When coca production is considered, however, a wage-risk demand that is more than proportional may not hold. For example, while landowners might well demand more than proportional increases in wages for a given increase in risk because of the potential seizure of output, confiscation of land, and threat of arrest, hired labor might have a wage-risk structure that is less than proportional since hired labor does not face the liabilities landowners do. In the aggregate, then, the combination of farmers' and hired laborers' wage-risk demands may work out to be proportional at the farm level.

Because coca producers are not likely to be as sensitive to changes in the risk environment as personnel at the higher end of the production chain, and to illustrate how the issue of risk premiums affects production, it is assumed that the demand for risk compensation rises linearly with the percentage of coca eradicated. In the extreme, as eradication approached 100%, wages in the coca sector would be nearly twice as high as wages in the legal sector. Using this assumption for

\footnote{For simplicity, the production function for cocaine assumes that the risks from natural hazards are distributed evenly over time. For more on explicitly accounting for yield uncertainty see Babcock (1990), Hildreth (1977), Miller (1986), Pope and Shumway (1984), and Weisensel and Schoney (1989).}

illustrative purposes, Figure 4.13 shows how the introduction of the wage premium affects cocaine production under 75% eradication.\footnote{An extreme scenario is used in order to obtain a sufficient level of risk that the impact of the wage premium can be discerned.}

![Graph showing the effect of wage premium on cocaine output.]

**Fig. 4.13—Effect of Cocaine Industry Wage Premium on Output**

When the wage premium is factored in, cocaine output falls slightly below the level of production that would occur without the wage premium. In addition, correspondingly less labor is used as labor is now more expensive in the cocaine industry. Intuitively, these are logical outcomes since the higher wages get passed along as cost increases. The important lesson from this analysis is that even though wages are elevated (75% in this case), and even though wages account for a large portion of coca industry costs,\footnote{Kennedy, Reuter, and Riley (1993a), Appendix.} the impact of the premium on output is very small because wages are such a small portion of street cocaine prices.
One interesting implication of this excursion is that if risk is a partial determinant of wages, then the threat of law enforcement will work to increase the traffickers' costs. If law enforcement causes a permanent increase in risk perceptions, it also causes a structural increase in wages. That is, the increase in wages is a permanent cost increase, rather than a temporary one induced by competition for labor services. However, it is more likely that the shock of law enforcement activity will recede, even if the law enforcement effort remains constant. As the shock of the new risk fades, compensation demands will decline as well. Only by continuously varying the law enforcement environment can the level of risk be permanently raised. Thus, Figure 4.13 probably overstates the impact of sustained policy measures on risk perceptions because it assumes that the shock of implementation never erodes.

The disadvantage, of course, is that a sustained law enforcement effort results in a very small decrease in production, at least under the risk-wage structure assumed. Additionally, as under other scenarios, all the traffickers have to do to evade the higher wage costs is relocate to a region where both factors of production are inexpensive. In this case, it would mean moving to an area with a lower law enforcement threat.
5. CONCLUSIONS

A systematic examination of source country cocaine control programs reveals that these policies are ineffective at reducing cocaine production permanently. Three factors account for the lack of long-run impact. First, the cost structure of the industry is such that even massive increases in intermediate product prices scarcely affect street retail prices. Source country programs must embody extremely large interventions if retail markets are to be significantly affected. Second, there are few methods of making the effects of massive intermediate price increases last because cocaine market signals work efficiently and because the factors of production, land and labor are abundant and not easily regulated. Third, all phases of production recuperate from policy implementation relatively quickly because the production process is extremely simple and mobile. Combined, the factors conspire to make the industry relatively impervious to source country control programs over the long run.

At the same time, the analysis also demonstrates some potential benefits of policy intervention against cocaine production. Perhaps the most obvious point is that the programs can interrupt the drug supply in the short run. Depending on how long it takes the weakest link of the production chain to recover from policy intervention, depending on the level of inventory held, and depending on the type of policy implemented, policy intervention may interrupt drug production for up to two years. Such interruptions should be regarded as potentially significant policy achievements.

Source country control programs are only one option for constricting the supply of drugs, and constricting the supply of drugs is only one way of addressing national drug abuse problems. Source country control programs, therefore, must fit into the larger context of fulfilling national drug objectives. These objectives, and the various approaches to reaching them, are coordinated at the national level by the Office of National Drug Control Policy, which annually publishes the National Drug Control Strategy. The role that source country control
programs play in a much larger national policy suggests two levels of analysis. First, what are the costs and benefits of source country control policies, and second, how can these policies best be used to ensure progress toward national drug control objectives? The subsections below consider these issues.

**THE MERITS OF SHORT-RUN DISRUPTIONS**

The main benefit from most of these source country control programs is that they can disrupt cocaine production for approximately two years. But of what practical use is short-run disruption if production capacity will only return to its prior capacity over the long run? The primary benefit is that restricting supply in the short run may beneficially change the shape of the demand curve for cocaine over the long run. This was discussed in section 4, but it bears repeating here. Restricting supply reduces initiation into cocaine use because casual and first-time users will be less willing to buy relatively expensive cocaine. Their reluctance may be related to the higher cost of the product, since new users might be more price responsive than regular users, or to availability issues, since heavy users will be better able to maintain access to supplies in times of scarcity.\(^1\) A lower initiation rate leads to fewer casual and heavy users, and, ultimately, less addiction.\(^2\) Thus, to the extent that future consumption is linked to levels of present consumption through addiction, a decline in present consumption will shift the future, long-term demand curve for cocaine inward.

It is important to consider what will happen to both those dissuaded from trying cocaine by higher prices and those who continue to consume cocaine at higher prices. Unfortunately, very little is known about how initiates might behave when the supply of drugs is tightened. Perhaps they will experiment with other drugs, perhaps not. Their reaction will undoubtedly depend in part on the availability and cost of

\(^1\)Dealers might be unwilling to sell to new users in times of scarcity, because, among other factors, new users are less likely to become repeat customers.

substitutes, as well as on their access to treatment and prevention programs. It is likely that children and teenagers, groups whose members may be particularly susceptible to drug-related harm, will be the first to feel the effects of a supply shortage because of their relative lack of access to regular supplies and their lower incomes.\footnote{Most experimental use begins in the teen years: few people initiate experimentation with drugs after the age of 25. Gerstein and Harwood (1990).}

Somewhat more is known about what current users will do when cocaine becomes scarce.\footnote{See Reuter (1993) for more an analysis of what substitutions might be made when drugs become scarce. See also DiNardo and Lemieux (1992).} Some will simply quit drug use, perhaps finding it a propitious time to seek treatment. Experience suggests that other current cocaine users will substitute for other drugs, although relatively little is known about what the substitutions would be. Heavy users are likely to assume greater risks to satisfy their now more expensive habit. Crack users, for example, might resort to prostitution to pay the higher prices, perhaps increasing both the social and individual costs of drug use through the increasing risks of acquiring HIV. There may be some changes in other criminal behavior to support the drug habit, although it is far from clear that a shortage of cocaine would lead to large increases in crime.\footnote{Wilson (1975) offers the classic analysis of heroin and predatory crime. Rasmussen et al. (undated), Benson et al. (1992) and Sollars (1992) discuss crime and drug use issues.}

In short, a market disruption is likely to reduce future demand. The short-run benefits of source country control programs are likely to be restricted to reducing the inflow of new users and the flow of casual users into heavy use. This in turn may lead to a decline in the long-run demand for cocaine, though the length of disruption required to reduce long-run demand needs to be more fully explored. These benefits will be offset some by modest increases in other types of substance abuse and risky behavior. With these benefits in mind, we can now turn to a more detailed discussion of the costs associated with short-term market disruptions.
THE COSTS OF SHORT-RUN DISRUPTIONS

Eradication

Recall Table 2.3, which summarized the history of eradication efforts in Mexico and BCP. With one exception, Peruvian eradication in 1988, the cost per hectare of eradication exceeded $1,500. Moreover, the costs presented in Table 2.3 only account for U.S. expenditures. When Mexico’s spending on the eradication programs in Table 2.3 is considered, the bilateral cost of poppy and marijuana eradication from 1984-1987 rises to $118 million, or over $10,300 per hectare. In any given period, eradication costs will likely increase linearly with the acreage eradicated. However, between any two periods, eradication costs are likely to increase extra-linearly as farmers attempt to evade eradication. Thus, shock eradication will be characterized by constant marginal costs since its operations are confined to one period, while periodic eradication will be characterized by rising marginal costs because its operations cover numerous periods. Voluntary eradication can be marked by constant or increasing marginal costs, depending on how it is implemented.

On the basis of the Mexican experience, shock and periodic eradication costs probably lie between $1,500 and $10,000 per hectare initially. At the lower end of the expense range, 50% shock eradication would cost nearly $200 million, whereas at the high end of the per unit cost range the bill would total almost $1 billion. Periodic eradication would incur these costs in every time period. For the second through approximately the sixth period of the periodic program, the total cost of eradication could climb slowly or even fall as rising marginal costs are offset by a lower volume of eradication. Eventually, however, both the marginal cost and the volume of eradication increase under the

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7Authorities can attempt to price discriminate and offer each person the minimum amount necessary to voluntarily eradicate, or they can offer one price and ignore the opportunity to capture the economic surplus. It is not clear which approach would be more expensive, since it would depend in part on whether the price discrimination option was implemented all at once or in a sequential fashion that raised the value of remaining land as plots were eradicated.
periodic program, and thus the total cost of eradication per period will increase as well. This complication will be ignored, and it will be assumed that the average yearly cost of a periodic program is equal to the total cost of the shock program. Thus, periodic eradication will be more expensive than shock eradication by a factor equal to the number of periods of eradication. Voluntary eradication can be completed at a cost much nearer to shock than periodic eradication because a large-scale voluntary eradication will logically only be offered once.8

The crude budget analysis does not consider some important factors that are difficult to quantify. Cocaine traffickers and dealers will enjoy inflated incomes even as the quantity of cocaine trafficked declines. The net rise in income occurs because the percentage rise in prices at each stage of production is proportionately higher than the percentage decline in production. The consequences of higher incomes in conjunction with restricted supplies are not certain, but some conjectures can be made. Greater income, for example, increases the traffickers’ ability to bribe authorities and to finance aggression against the states. In the United States, the change in market conditions might well spark a competition between retailers that would lead to a resurgence of the violent confrontations that have marked other periods in retail cocaine markets’ history.9

In Bolivia, Colombia and Peru, the consequences of substantial eradication will depend partly on the type of eradication implemented but could imperil the functioning and stability of the national governments. Cocaine traffickers in Colombia have repeatedly demonstrated the willingness to attack the state in pursuit of drug trafficking objectives.10 As cocaine production is disrupted, this type

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8To compensate for voluntary eradication once the original acreage is gone is to insure coca farmers against market conditions, and thus, in effect, to subsidize production.


of violence by traffickers against the state may surge in Colombia again.

Eradication could also lead to an increase in political violence at the farm level. Forced eradication will almost certainly provoke violence among the farmers and could, for example, serve as the catalyst for increasing the farmers' affinity to non-governmental organizations such as the Shining Path in Peru, death squads in Colombia, and coca unions in Bolivia.¹¹ Voluntary eradication, because it provides the farmers with compensation, is much less likely to incite violence. If compensation or alternative sources of income are provided, the costs associated with eradication would rise, perhaps substantially. By one estimate, it would take an investment of approximately $5 billion to hold Andean workers' wages steady after the elimination of the drug trade.¹²

While the eradication program itself may or may not be temporary, there is no guarantee that the political consequences of the intervention would die out. Indeed, it is possible that the policy would set in motion a response that is not easily reversed. The potential for an increase in drug-related violence would surely undermine public and official support for the eradication program in BCP. If the Andean nations are willing to assume the risk of increased violence, the United States would probably have to incur the cost of supporting the Andean governments against the increase in violence, adding to the costs associated with an expansion of eradication programs. Thus, U.S. support for eradication also implies a sustained commitment to ensuring political stability in the region, a task that could add substantially to the cost of the program.

Interdiction

According to Table 2.6, authorities seized over 60 MT of cocaine under Operation Snowcap in 1990. For that year, Snowcap was funded with a total of $7.3 million, yielding an average cost of seizures of

¹²Kennedy, Reuter, and Riley (1993b).
$118,000 per metric ton. At the opposite extreme, Rydell reports figures that imply costs exceeding $25 million per metric ton seized.¹³ All that can be said with certainty is that the Snowcap figures omit a number of important factors, such as source country expenditures and the value of law enforcement infrastructure developed under other programs, and thus the true cost of seizures is probably substantially higher than implied by Snowcap. At the same time, Rydell’s data contain the costs of expensive U.S. military surveillance and intelligence contributions that do not take place within the confines of the source countries, and thus they are likely to overstate the cost of source country seizures.

Unlike eradication, interdiction will likely face rising marginal costs in the first and all subsequent periods that the policy is in operation. Rising marginal costs occur in every period because interdiction involves the interception of small, mobile packages that are easily concealed and rerouted. Since there is no ability to estimate rising marginal costs within a period, let alone across periods, an average cost figure will be used. A best guess of average costs would place the figure nearer the high end than the low end of the spectrum. The figure $15 million per MT is not unreasonable, keeping in mind that it is an average. At this cost, 50% shock interdiction would cost approximately $2 billion; periodic interdiction would cost approximately the same amount multiplied by the number of periods in which the policy was implemented.

Interdiction is also saddled with the same intangible costs that are associated with eradication. That is, the policy will increase the profits from drug trafficking and potentially increase domestic confrontations over market share. Similarly, it will exacerbate source country political tensions by increasing the likelihood that the traffickers will resort to violent means to protect their market share.

A distinction between the two types of interdiction policies needs to be made. Recall that under shock interdiction, production is only disrupted for six months, but that under sustained interdiction, output is suppressed for two years. The effects of shock interdiction last

only as long as the policy is in effect; once the policy terminates, production rebounds quickly because the infrastructure of the trade is not affected. A six-month disruption, while an admirable policy achievement, may not be sufficient to suppress initiation rates or otherwise significantly affect long-run consumption patterns. In some sense, the Colombian crackdown on refineries and production capacity in late 1989 and early 1990 was an experiment that informs about the possible consequences of large-scale interdiction and the utility of market disruption.

In scale and intensity, Colombia’s efforts against the drug industry during this period were unprecedented. In late 1989 and early 1990, authorities interdicted approximately 10% of the cocaine processed and exported from Colombia; destroyed over 100 processing laboratories, 29 of which were described as major refining centers, and arrested thousands of suspected traffickers, several of whom were extradited to the United States.\textsuperscript{14} Combined, the elements of the strategy had a significant temporary effect on drug production. Traffickers fled to Bolivia, Panama, and other relatively safe havens, and power in the cocaine industry shifted from the Medellin to the Cali cartel.\textsuperscript{15} The traffickers’ movement and the government’s attacks caused a shortage of refining capacity that significantly reduced Colombia’s export capacity for a time.\textsuperscript{16}

Recall from Figure 4.12 that street retail cocaine prices increased significantly after the law enforcement surge.\textsuperscript{17} Figure 5.1 shows the price increases in more detail. The increase in prices was primarily concentrated in the September 1989 to March 1990 period. After March 1990, prices began to drift downward, although there were substantial fluctuations.

\textsuperscript{15}Lee (1991).
\textsuperscript{16}Andreas et al. (1991-1992) report that “cocaine processing and trafficking dropped 70 percent” in the aftermath of the crackdown.
\textsuperscript{17}Changes in prices cannot be attributed solely to the Colombian strategy, because other changes in law enforcement efforts (noted in section 4) were taking place.
Fig. 5.1—Monthly Purity-Adjusted Street Retail Prices, 1989-1992

The question is whether this period of disruption over the short run is sufficient to affect demand over the long run. The trough-to-trough increase in prices lasted approximately 16 months, from January 1990 to April 1991. However, prices remained above $150,000 per kilo, an approximate 10% increase over the base case price, consistently for only eight months. A 10% increase in costs can probably be passed along by diluting the strength of the product, rather than by raising the actual retail price, with little risk of losing customers. In other words, it is probably fairly easy to maintain sales volume in the advent of a 10% cost increase by cutting the strength of the cocaine. It is more problematic to pass along a 50% increase in costs without the volume of sales being affected.

There is no way to tell yet whether this disturbance has affected future use of cocaine. In all likelihood, the disruption did not make a substantive difference in future cocaine use primarily because it did not last very long and for most of the duration the effect on prices was
weak. Nevertheless, the example does demonstrate that law enforcement programs can successfully disrupt supplies.

Implementation of the policy was expensive, both in terms of budget and intangible costs. The United States, under the Andean Initiative, provided Colombia with hundreds of millions of dollars of assistance in the form of military equipment, credits, and training.\textsuperscript{18} Operational costs are not known but undoubtedly added millions more to the total.

The cost to Colombians of this effort, however, was dramatic. The crackdown intensified a period of virtual war between the traffickers and the government. As Colombian policy efforts escalated, so did traffickers' response. The drug lords assassinated numerous public officials and carried out spectacular terrorist acts in public to protect their interests.\textsuperscript{19} It is difficult to put dollar value on these costs, but many sectors of the economy were disrupted by the conflict. Foreign investment fell, construction plummeted, and tourism suffered.\textsuperscript{20} The level of violence further eroded the public's confidence in the state's ability to protect its citizens.

**Development Assistance**

As noted in section 4, development assistance promises to be an extremely expensive route to reducing cocaine production in the short run. The amount of capital investment required to create a development assistance program with effects comparable to 50% eradication or interdiction would run in the trillions. Thus, while development assistance might well cause the least amount of political unrest because of its voluntary nature, these savings are swamped by the budgetary costs of the program.

**Summary of Short-Run Costs**

A rank-ordering of source country control policies by budget costs would probably find shock eradication and shock interdiction at the

\textsuperscript{19}See Riley (1993).
\textsuperscript{20}Lee (1991).
lowest end of the cost spectrum, with total program costs of $200 million to $2 billion (perhaps more, depending on marginal cost increases for the latter), voluntary eradication at an intermediate cost (approximately $4 billion, depending on method of implementation) and periodic eradication and periodic interdiction with much higher price tags because of rising marginal costs and the need to repeat the programs across numerous periods. All the programs would generate an approximate two-year disruption of production, except shock interdiction, which has much shorter effects. Table 5.1 summarizes the analysis from sections 4 and 5 relating to source country control programs.

All the programs are likely to have similar, and potentially substantial, intangible costs as well. The eradication programs could stimulate strife both among the farmers and the drug traffickers, the former a group that has previously not been a source of political unrest at the national level. Interdiction is likely to primarily affect the traffickers, and Colombia’s experience indicates that a short-run disruption of cocaine markets through interdiction comes at a cost of increased confrontation with them. The intangible costs associated with the source country control programs would increase the need for auxiliary policies that would add additional billions to the cost of counternarcotics policies in the Andes.
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<td>Shock Eradication</td>
<td>opposition to targeting farmers; technical barriers</td>
<td>high</td>
<td>none on output; possible decline in demand</td>
<td>long lag; need knowledge of inventory to capture short-run gains</td>
<td>moderate ($200m-$1b, one time)</td>
<td>potential for violence; dispersal of trade</td>
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<td>Periodic Eradication</td>
<td>extremely difficult politically; efficiency likely to fall over time</td>
<td>high</td>
<td>none on output; possible decline in demand</td>
<td>long lag</td>
<td>high ($200m-$1b+, annually)</td>
<td>increases industry’s production capacity; potential for violence</td>
</tr>
<tr>
<td>Shock Interdiction</td>
<td>somewhat easier politically; modest implementation issues</td>
<td>high</td>
<td>none on output; least likely to reduce demand</td>
<td>very short lag; need knowledge of inventory to capture short-run gains</td>
<td>moderately high ($1b-$2b, one time)</td>
<td>potential for violence; dispersal</td>
</tr>
<tr>
<td>Periodic Interdiction</td>
<td>efficiency likely to decline over time</td>
<td>high</td>
<td>none on output; possible decline in demand</td>
<td>long lag</td>
<td>high ($1b-$2b, annually)</td>
<td>increases industry’s production capacity; potential for violence</td>
</tr>
<tr>
<td>Voluntary Eradication</td>
<td>politically acceptable, but deceit a problem without coercion</td>
<td>low</td>
<td>none on output; possible decline in demand</td>
<td>long lag; need knowledge of inventory to capture short-run gains</td>
<td>approx. $4b, depending on method</td>
<td>dispersal of trade; development sites easy targets</td>
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<td>Development Assistance</td>
<td>impractical because of costs; slow in comparison to other options</td>
<td>low</td>
<td>none on output; possible decline in demand</td>
<td>lag depends on response method</td>
<td>extremely high (&gt;5b for 5% reduction)</td>
<td>dispersal of trade; development sites easy targets</td>
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SOURCE COUNTRY CONTROL AND NATIONAL DRUG CONTROL STRATEGY

The objective of national drug control strategy is to reduce the consumption of all drugs, not just cocaine. Additionally, the intent is to reduce consumption of cocaine among all user subgroups, such as teenagers, heavy users, and so forth. Source country control programs share the national drug control agenda with three other policy instruments. The largest component of the national drug control budget is domestic enforcement and border interdiction. These programs consume about 50% of federal spending. Treatment programs are the next largest element of the national strategy, consuming roughly 16% of federal drug resources. Prevention programs receive about 12% of federal funds, though many of these programs have law enforcement components to them. Source country programs account for about 6% of the total. The balance of federal spending is divided among a variety of other programs, such as regulatory matters and research and development. The emphasis on reducing use, as opposed to harm minimization and other potential strategies, is unlikely to change significantly over the next few years, and so source country control programs should be considered in the context of their impact on the existing national strategy.

The diverse elements of the federal drug strategy are in competition with one another for scarce resources. Expansion of source country control programs would mean that fewer resources are available for other strategy elements, assuming the national drug budget is relatively fixed or constrained. However, expansion of source country control programs might logically be paired with expansion of other elements of the national strategy to maximize the overall progress toward national drug control objectives. The subsection below considers

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22Domestic enforcement programs are analytically distinct from source country control programs because they operate much closer to retail markets, exert more leverage over domestic markets, and are fully under U.S. control.
24For more on other national drug strategies, see Nadelmann (1992b), O’Hare et al. (1992), and Kleiman (1992a and 1992b).
the implications of expanding source country control programs for the rest of national drug strategy.

**Expanding Source Country Control**

The utility in expanding source country control programs lies in the potential to temporarily disrupt the markets. Expansion should be designed to work in conjunction with the other elements of national strategy to maximize the benefits of this disruption. To that end, expansion of source country control programs would probably require a relative increase in emphasis on treatment and prevention to further suppress long-run demand.

There is some danger that unless treatment and prevention programs are expanded to capitalize on the market disruption, consumption will return to its previous pattern when the interruption ceases. Experience with such phenomena is limited, but the 1989-1990 price increase provides some indication that the disruption needs to be more enduring to have a lasting impact. Similarly, heroin consumption seems to supply one recent example. Heroin markets were disrupted in the second half of the 1970s, and heroin use appeared to decline in response.\(^{25}\) In the interim, addicts availed themselves to domestic substitutes, but after supplies increased later in the decade, there was a marked resumption of heroin use. The heroin users who relapsed are typical of many drug users. Often detoxification, staying away from drugs for the time it takes to rid the body of their presence and to take care of immediate drug-related medical consequences, is insufficient for gaining control over substance abuse problem. Periods of relapse can occur after many drug-free years. Thus, drug users are vulnerable when supply restrictions are eased.

Treatment and prevention may be able to prevent some of this backsliding. Typically, treatment is sought after drug-related problems have led to a deterioration in the quality of life. The unavailability of cocaine may force changes in drug-seeking behavior that precipitates such a deterioration, or sporadic availability during a period of

\(^{25}\)Reuter (1993).
tightened supply might increase awareness about search costs, risks, and other factors associated with dependence. As those unable to obtain cocaine during a market disruption turn to treatment, the demand for such services will increase. Recent estimates indicate, however, that treatment slots may already be in short supply. Treatment programs might be particularly useful in rural areas, where supply is likely to contract first, and where treatment facilities are relatively more scarce.

Prevention serves both as an adjunct to treatment and as an independent policy of its own, and its importance is likely to increase as cocaine becomes scarce. Prevention programs work to impede relapses by creating an environment that breaks the links between situational and environmental cues and drug use. Thus, one aspect of prevention is to attack the correlates of drug abusing behavior: lack of education, employment opportunities, and homelessness. A second aspect is to provide programs that warn of the consequences of relapse. Examples here include drug testing in the workplace and the criminal justice system. Prevention will also have a heightened duty among casual, novice and initiate users deterred from cocaine use by unavailability since these people are at some risk of becoming users when supply restrictions are eased.

A FINAL WORD

By themselves, source country control programs are incapable of curing the nation's cocaine problem. Simply put, cocaine production defies regulation over the long run. In the short run, however, source country control programs can prove disruptive. Such disruptions, in conjunction with other elements of the national drug strategy, may combine to yield progress toward national drug objectives. The relatively low level of current source country program funding is not appreciably or consistently constricting supply. The most likely consequence of maintaining current source country control spending is

that the programs will continue to consume scarce resources without providing much benefit.

Given the small size of existing programs and their inability to significantly affect cocaine availability, the most compelling justifications for a maintenance approach are found outside the confines of national drug control objectives. Support for operations in Latin America, for example, provides data on the size and structure of the international drug trade, and these data are important for assessing the size of the drug abuse problem. Additionally, the maintenance strategy allows the United States to provide support for foreign policy objectives. It allows the United States, for example, to provide assistance to Colombia and Peru without directly becoming involved in these nations’ guerrilla wars. Similarly, narcotics assistance provides leverage in matters such as international trade insofar as narcotics assistance can be, and is, linked to these issues. Expansion of source country control programs will more than likely complicate international relations and could well imperil U.S. objectives regarding political stability and security in the Andes. The foreign policy implications of expanding source country control programs deserve serious consideration before the existing strategy is radically altered.

Source country control programs, indeed much of our national approach to drug control, are at a crossroads. Frustration continues to mount over lack of progress against the nation’s drug problem in general and drug trafficking in particular. Toward the goal of implementing a more effective national drug control strategy, this analysis sought to clarify some points about the efficacy of source country control programs, the impact they have on the cocaine industry, and their potential role in national drug control strategy. While much research remains to be done on how to best fulfill national drug control objectives, this research has helped identify the strengths and weaknesses of source country control programs and has identified issues that need to be addressed before substantial changes in source country control programs are enacted.
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